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LSR 81

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For the small scale precision cutting or grinding job, with mounted grinding wheels and points or with Sandvik Coromant tungsten carbide cutters, today's most highly developed grinder is the Atlas Copco LSF12 shown here. Speed is governed and constant. Accuracy of running extreme. Speed 27,000 r.p.m. Weight 1¼ lbs.

WRITE FOR LITERATURE Full details about these products are contained in leaflet E811 which will be sent on request.



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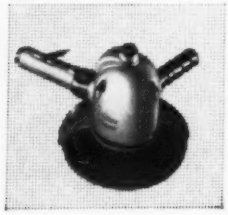
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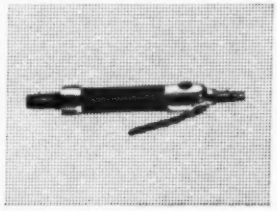
In the U.K. Atlas Copco (Great Britain) Ltd., Hemel Hempstead, Herts.

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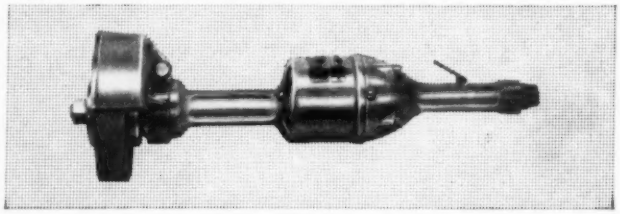
LSS 82



LSF 12



LSR 61



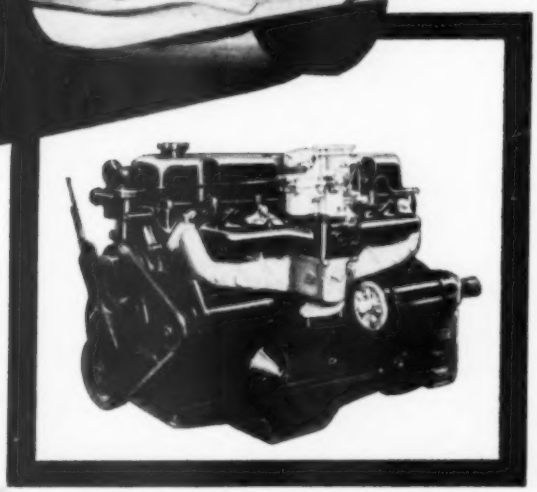
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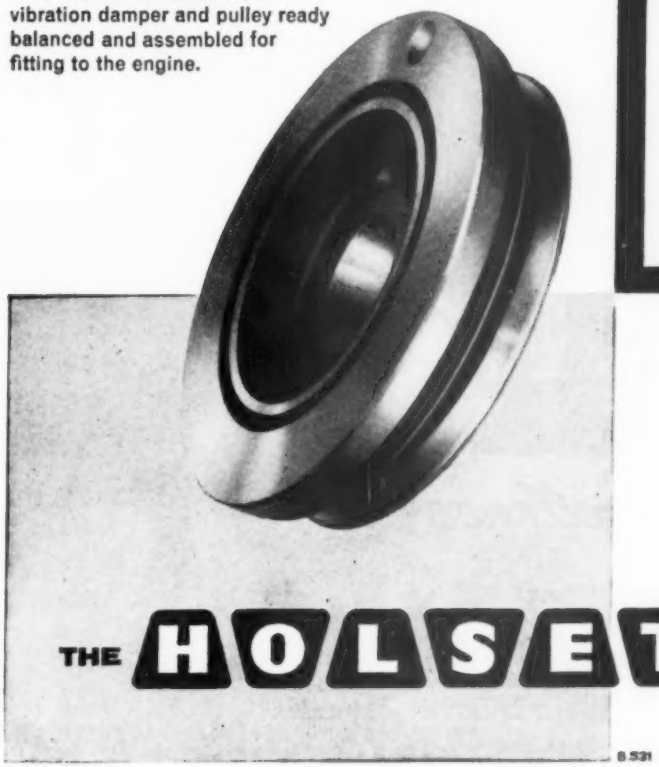
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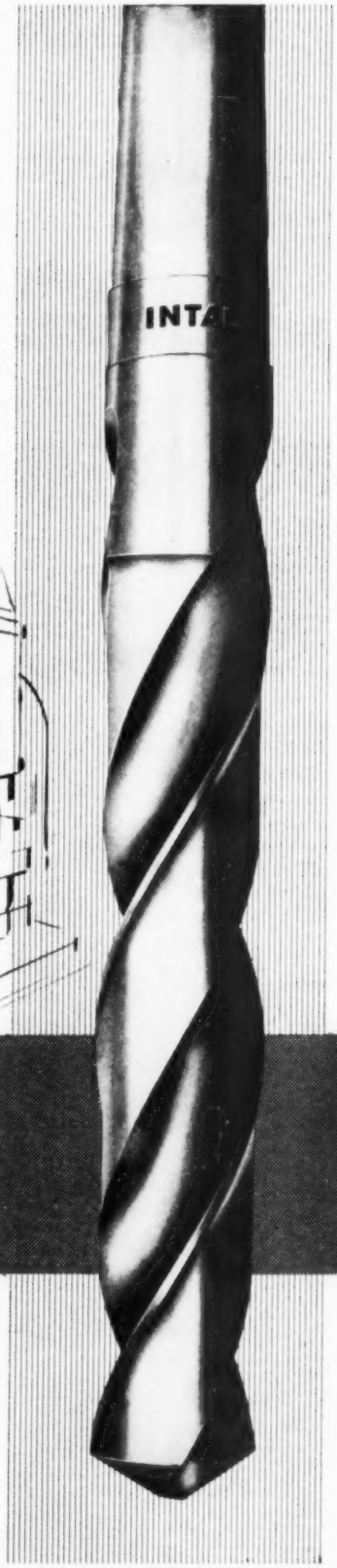
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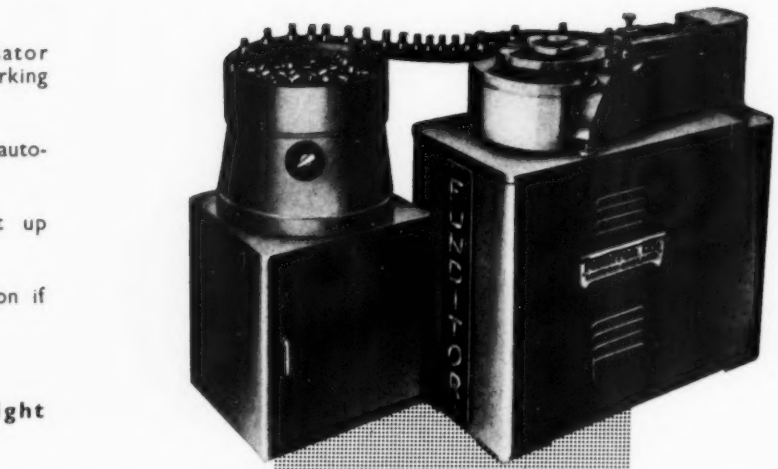
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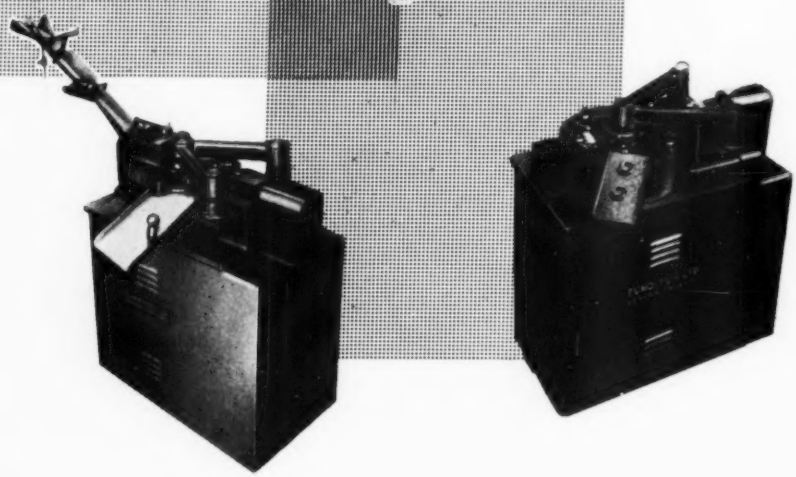
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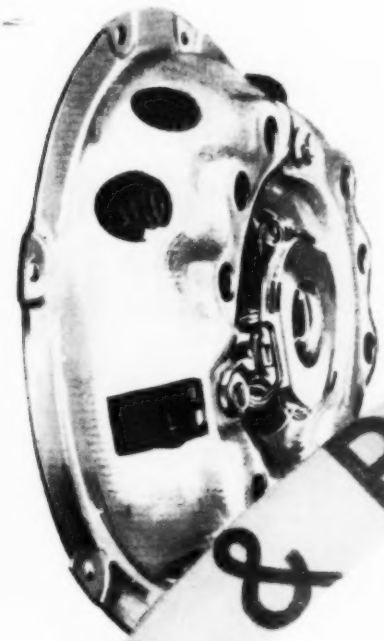


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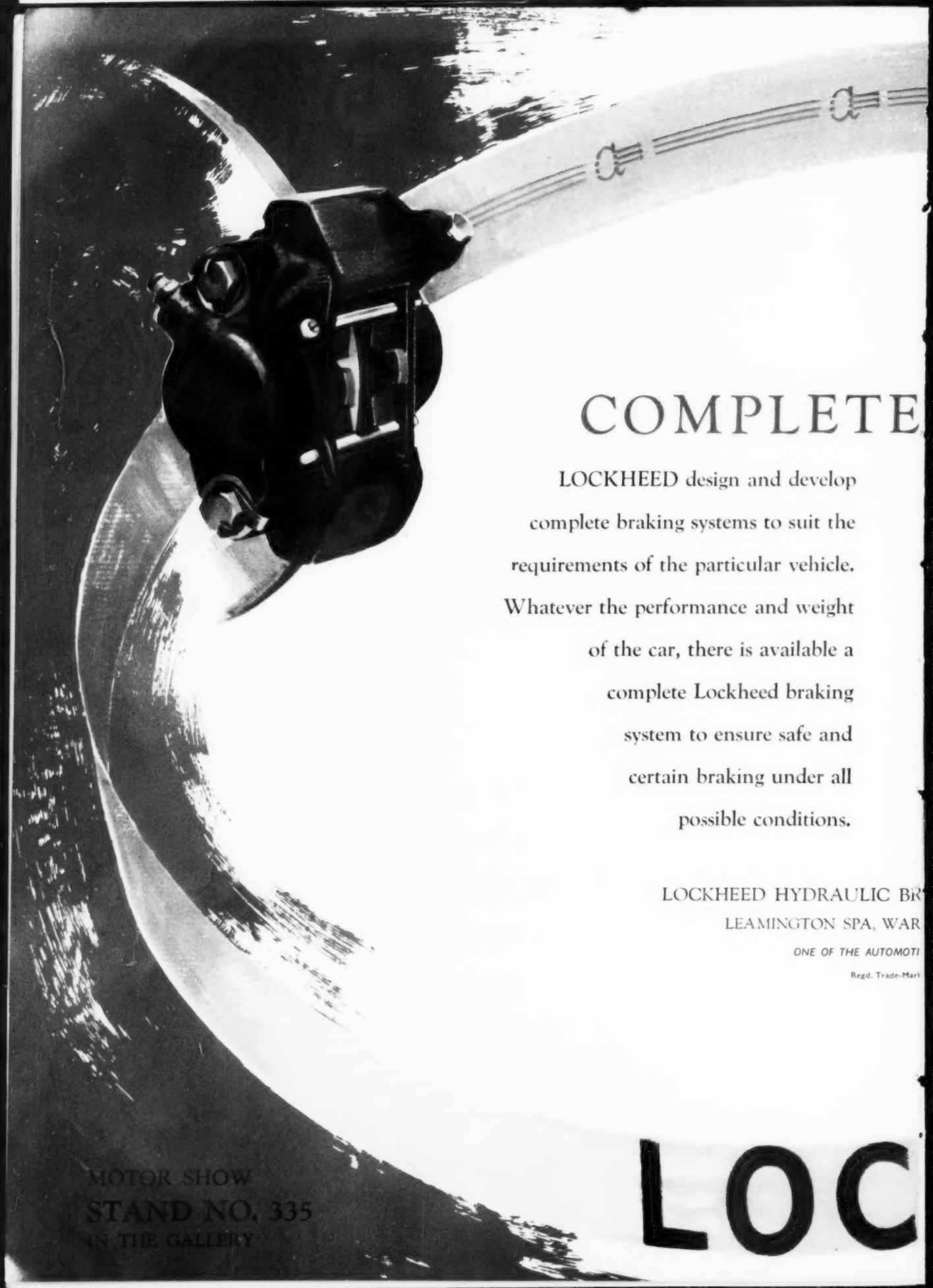
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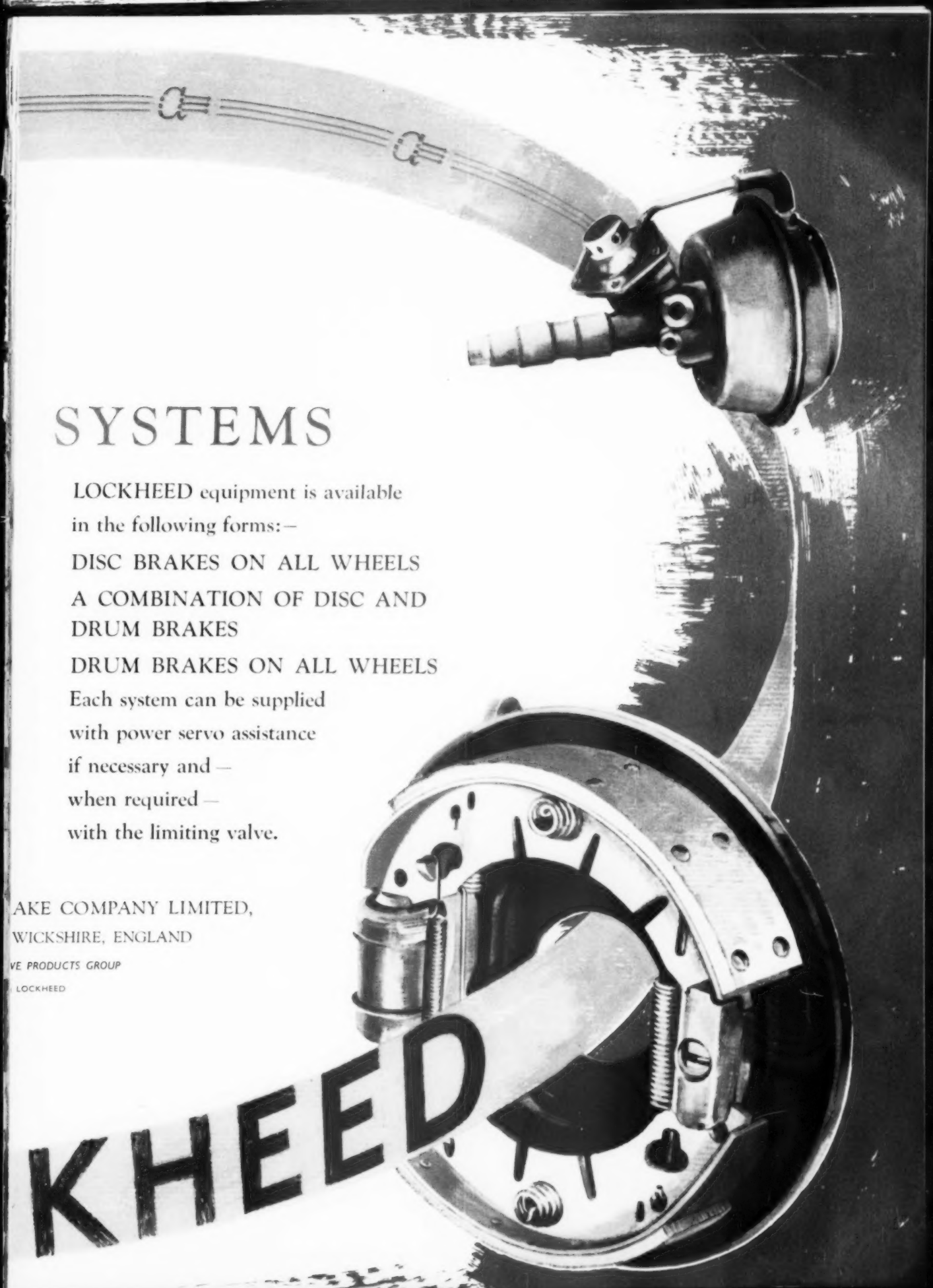
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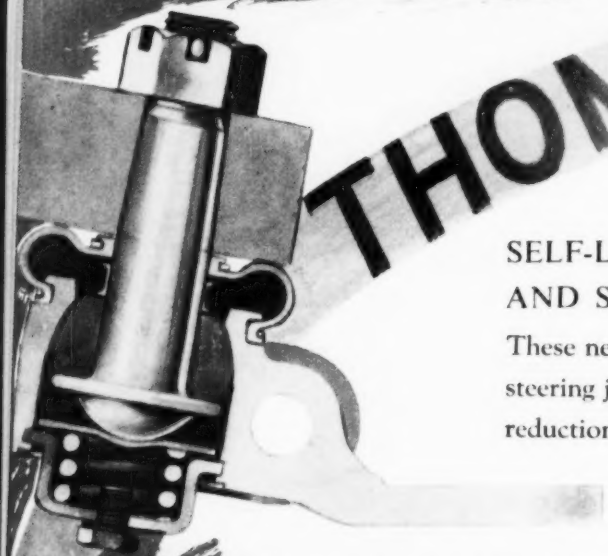
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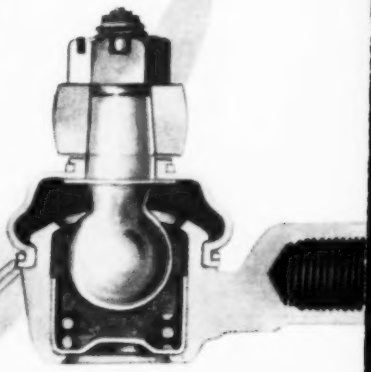
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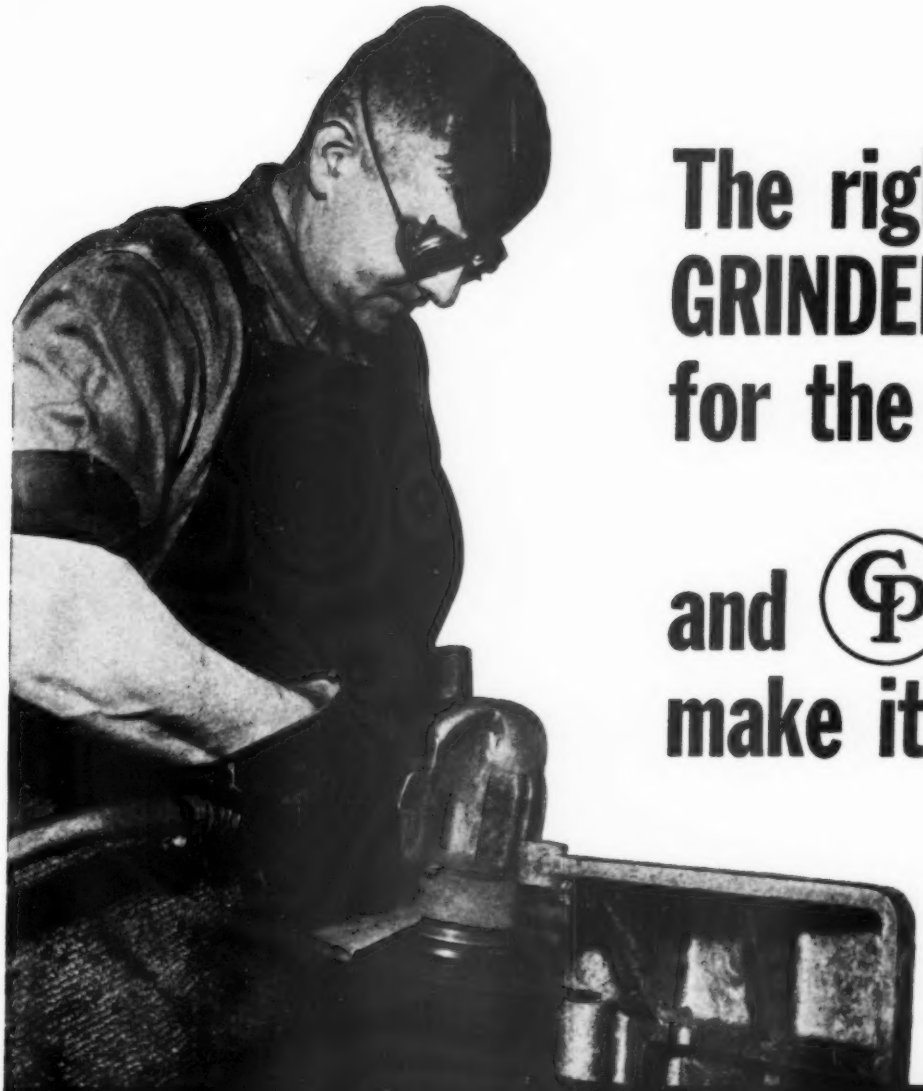




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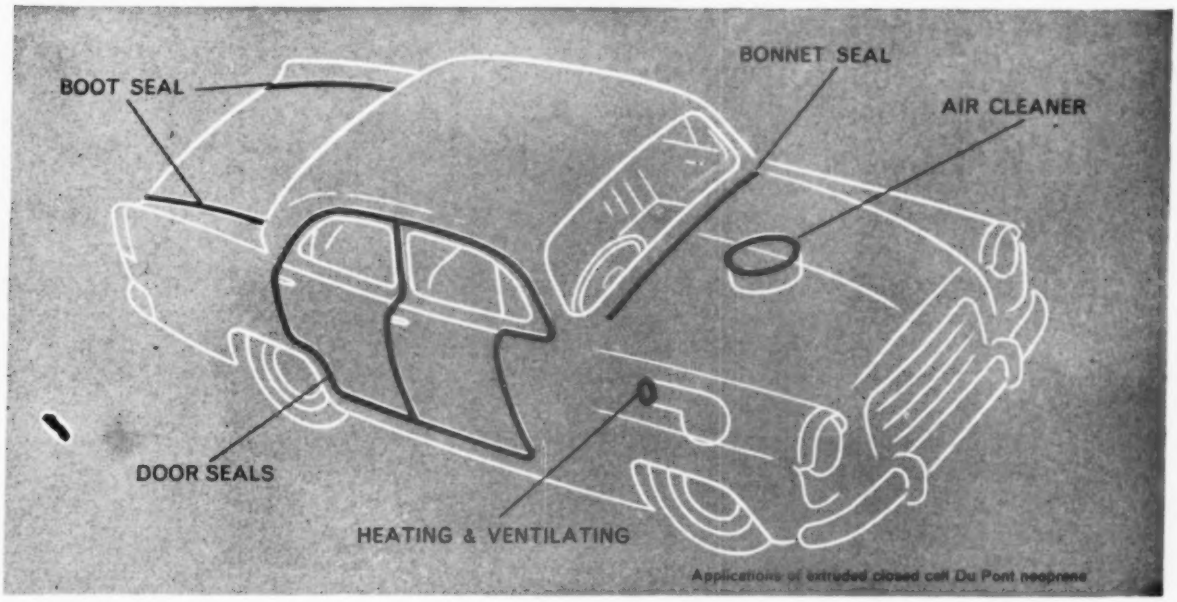
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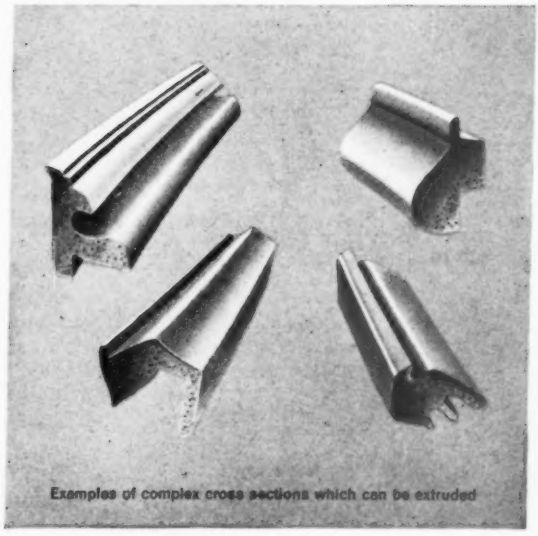
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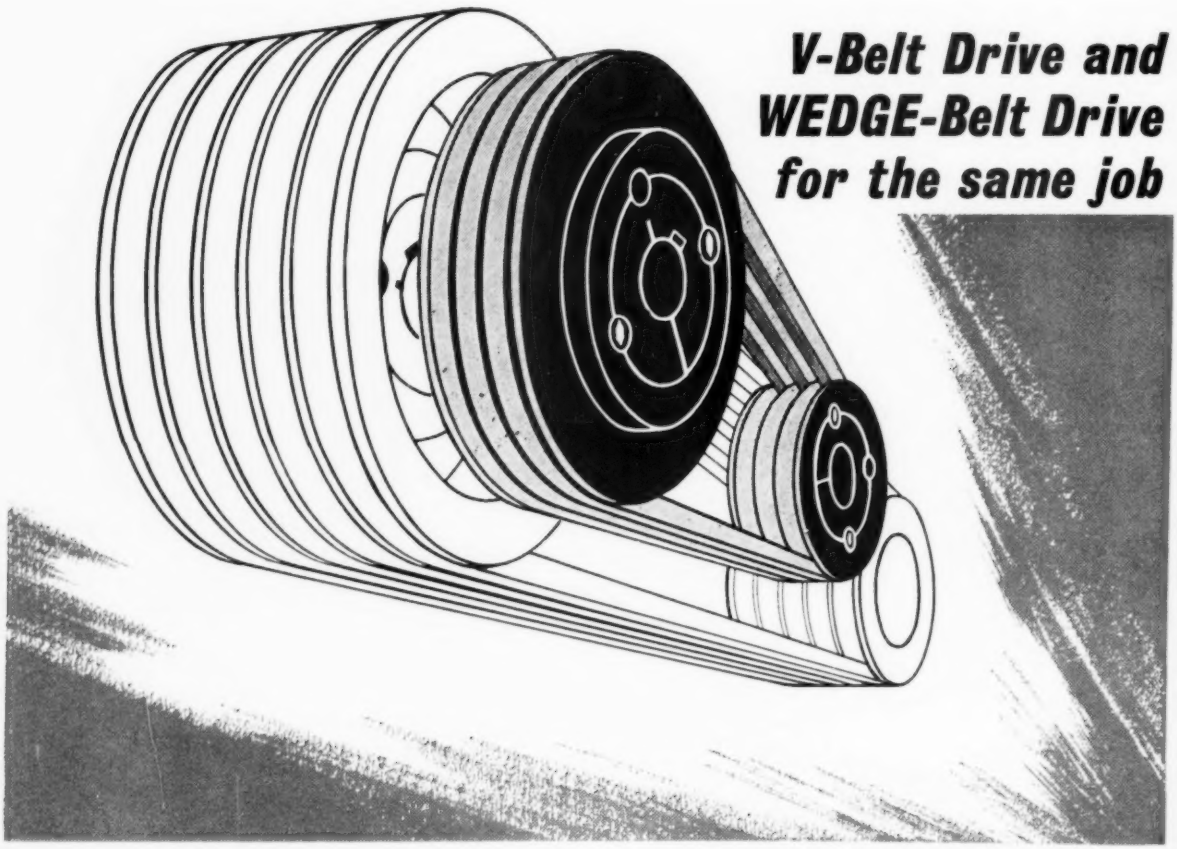
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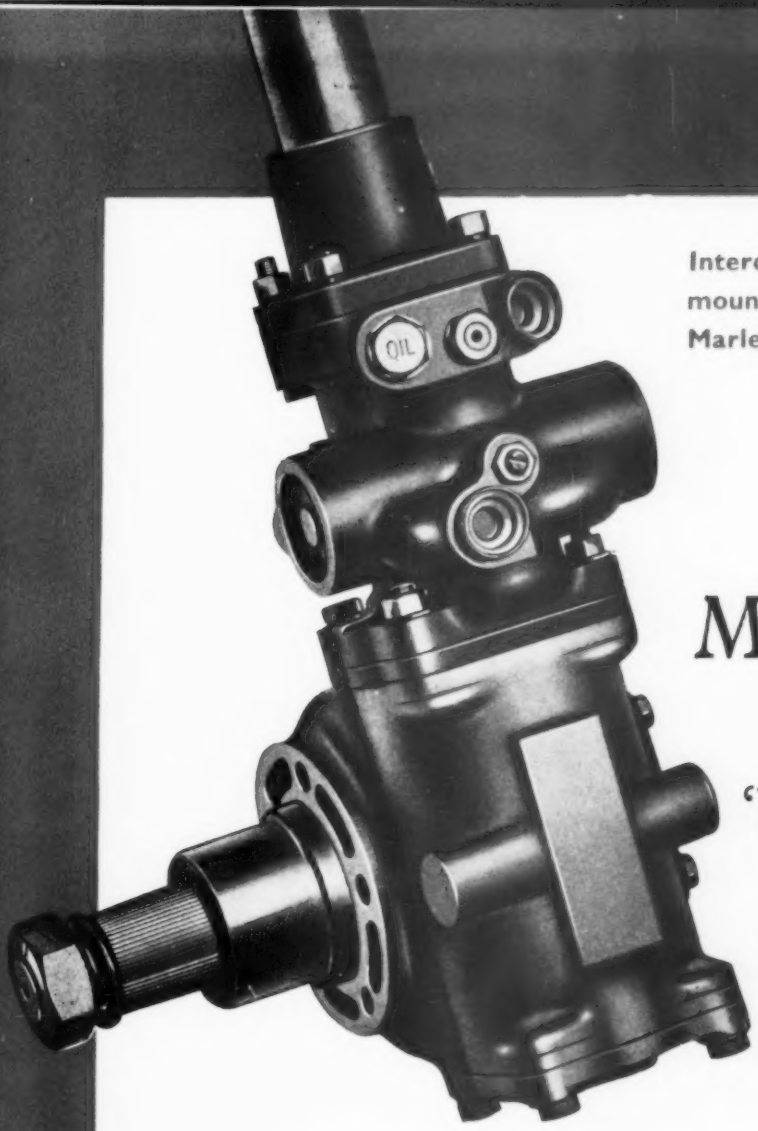
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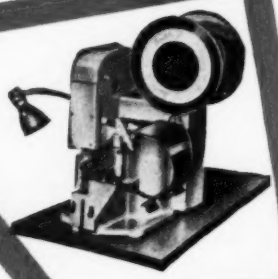
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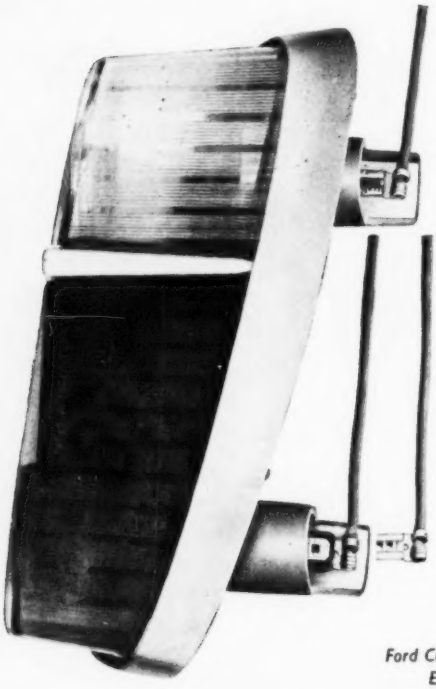
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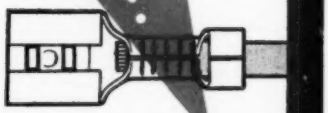
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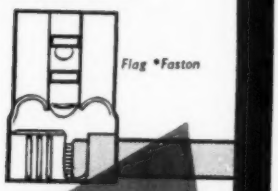
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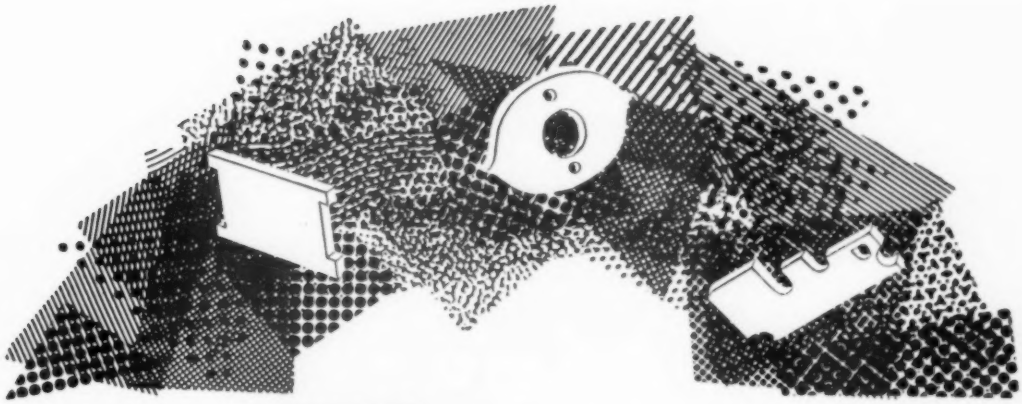
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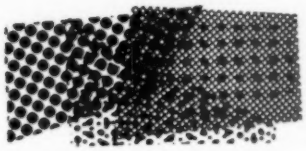
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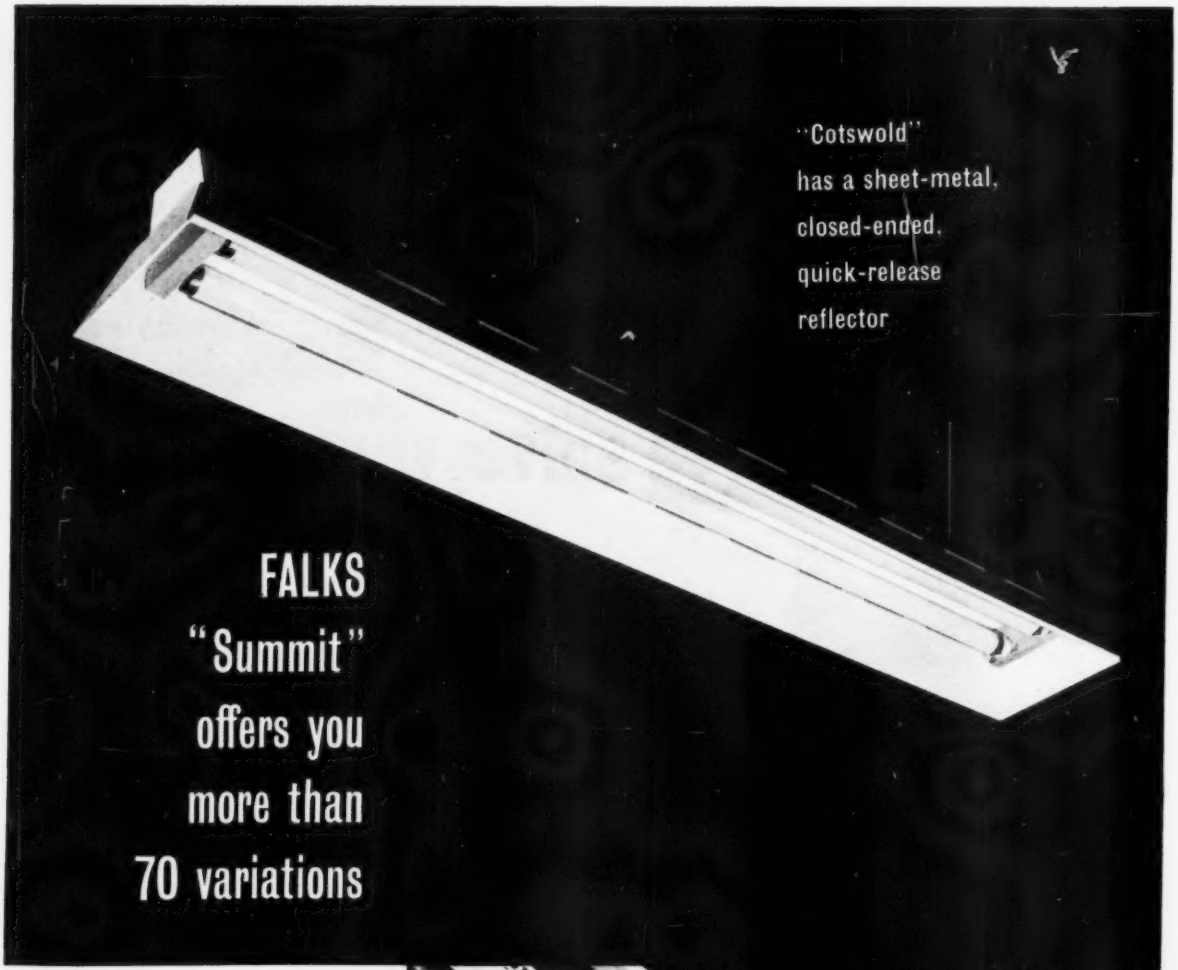


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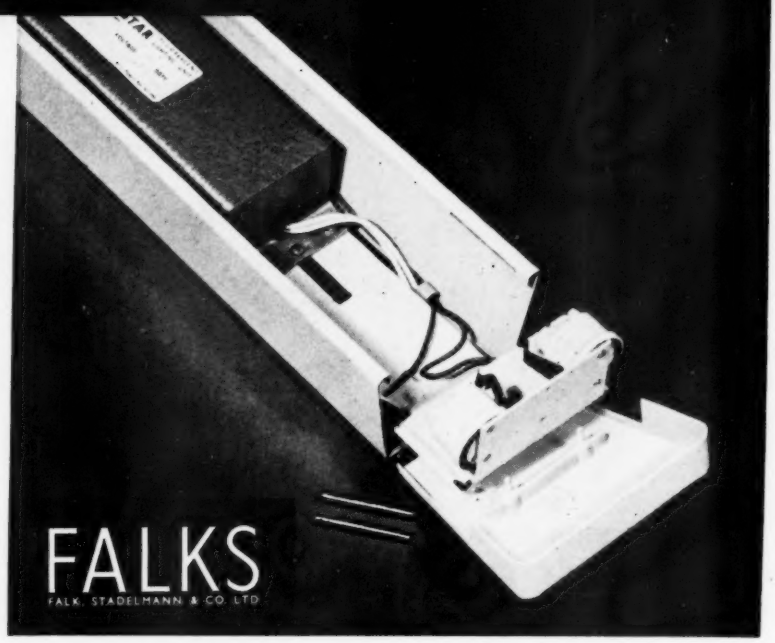
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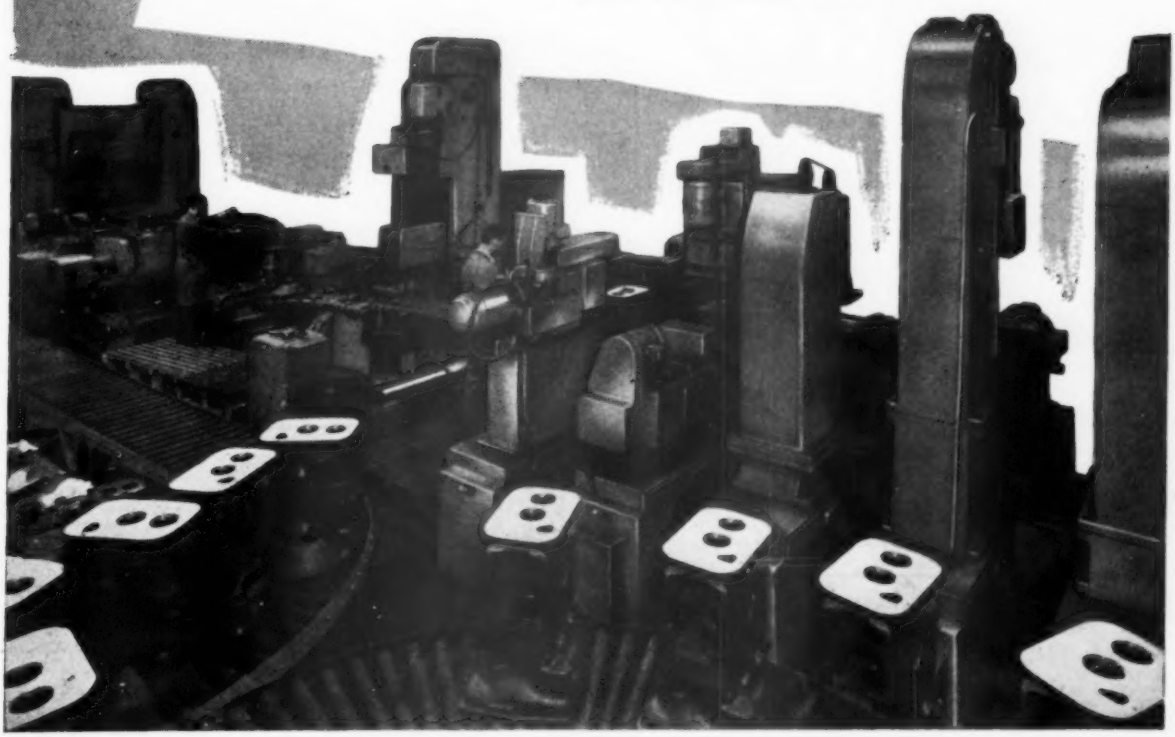
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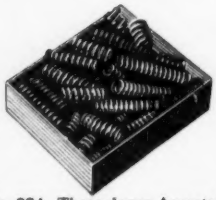


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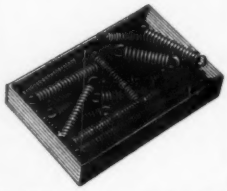
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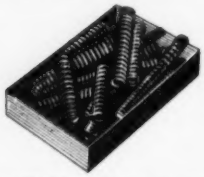
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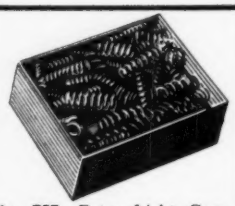
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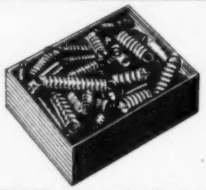
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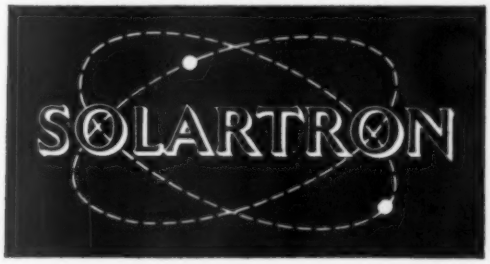
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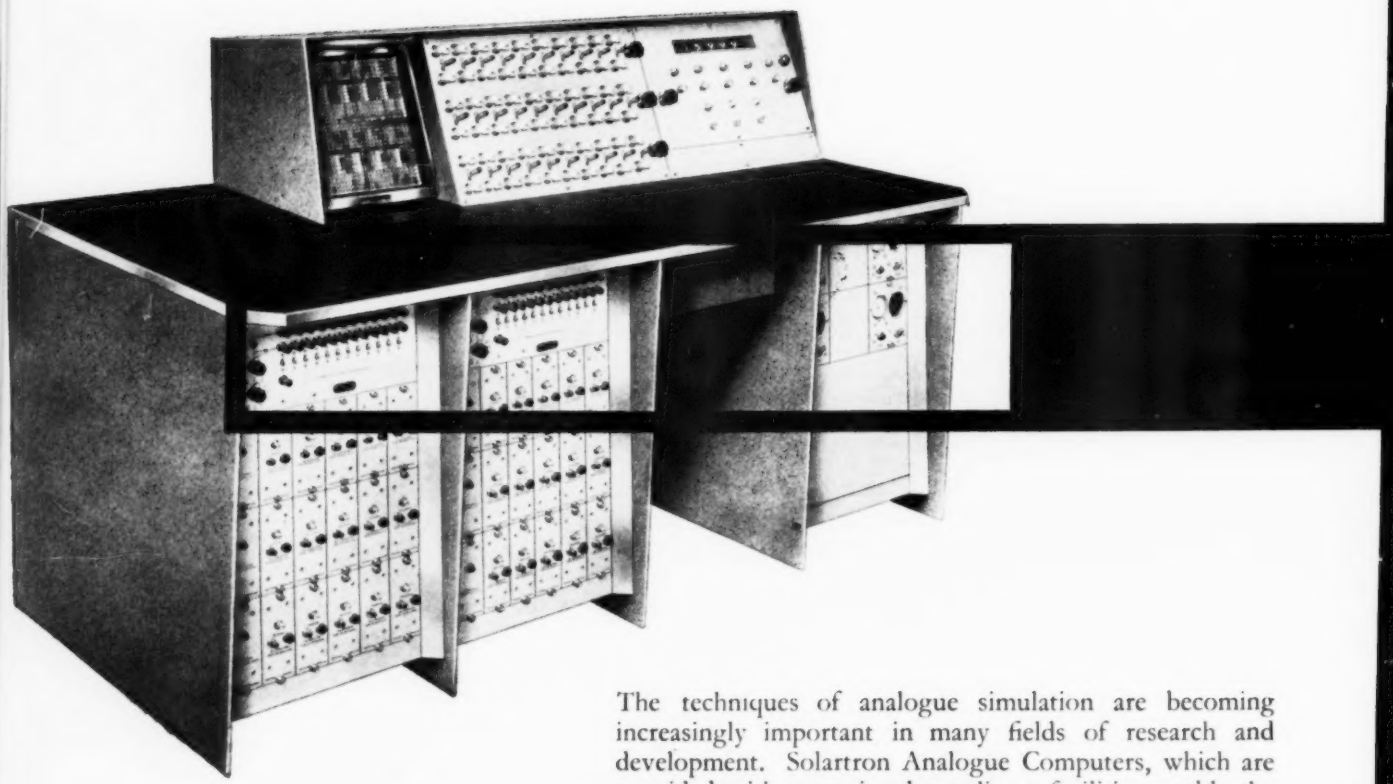
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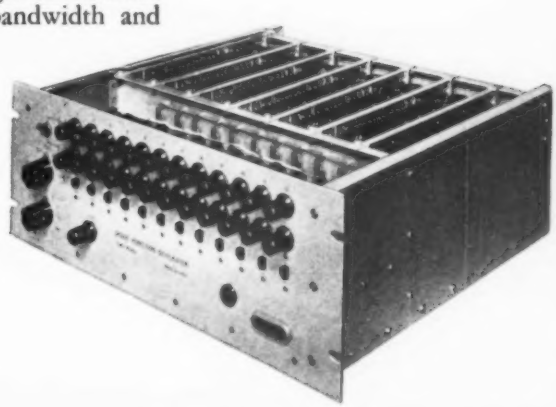
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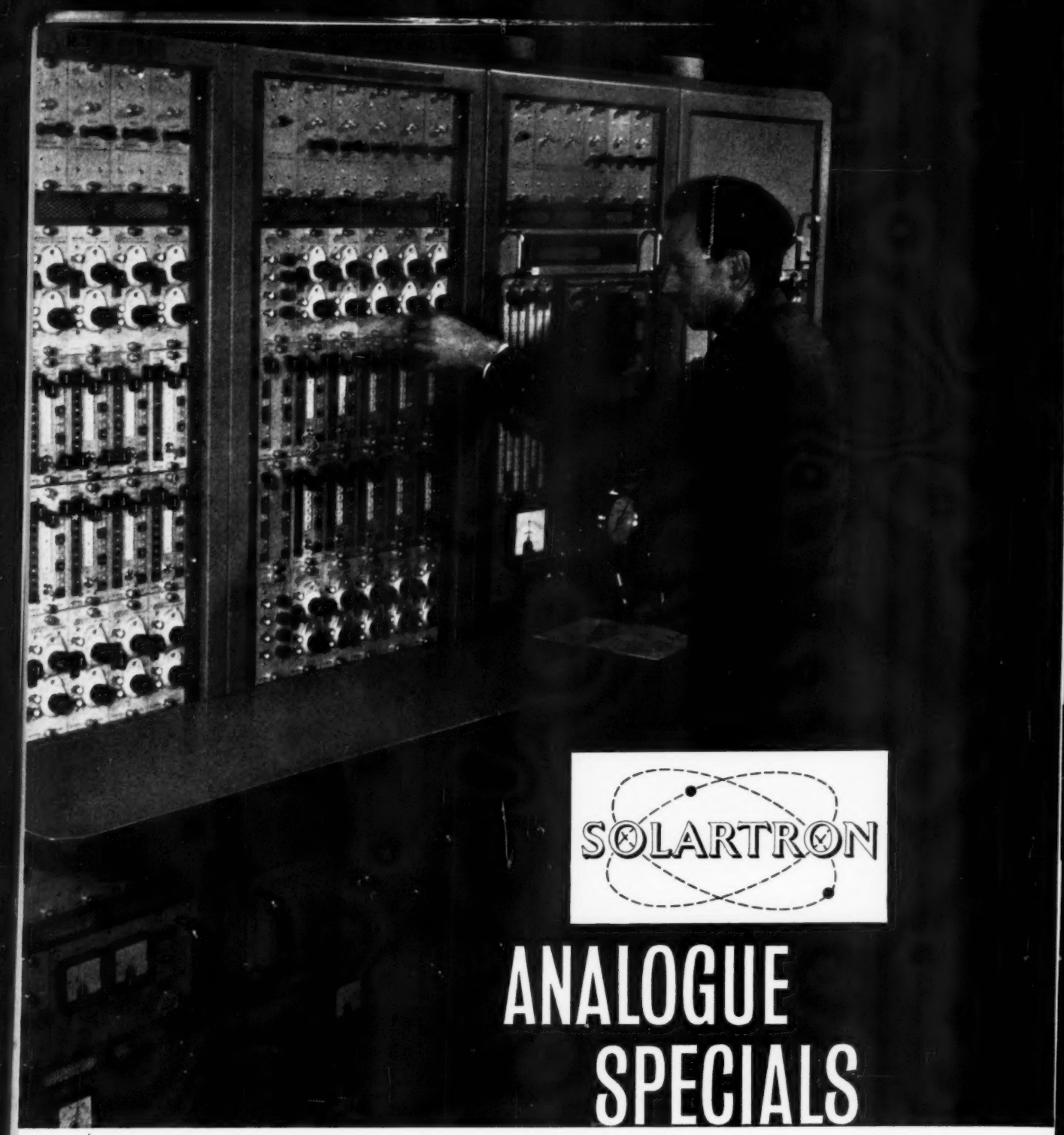
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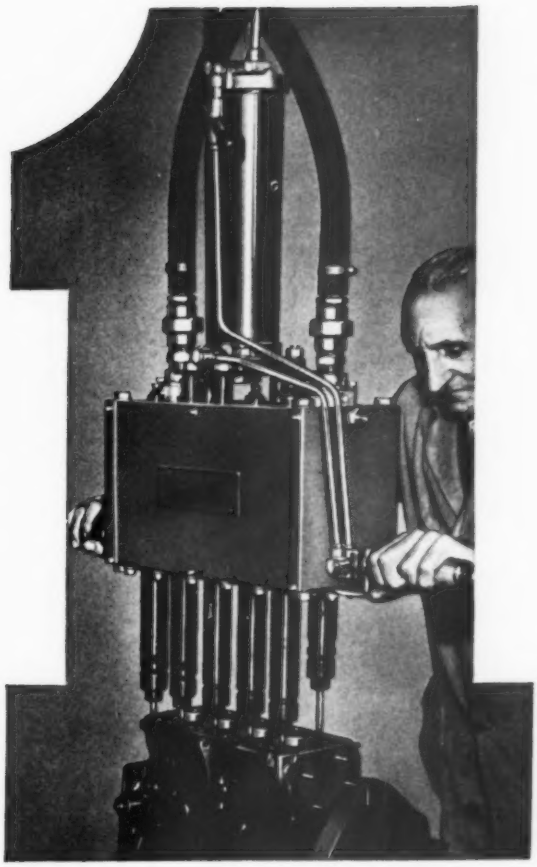
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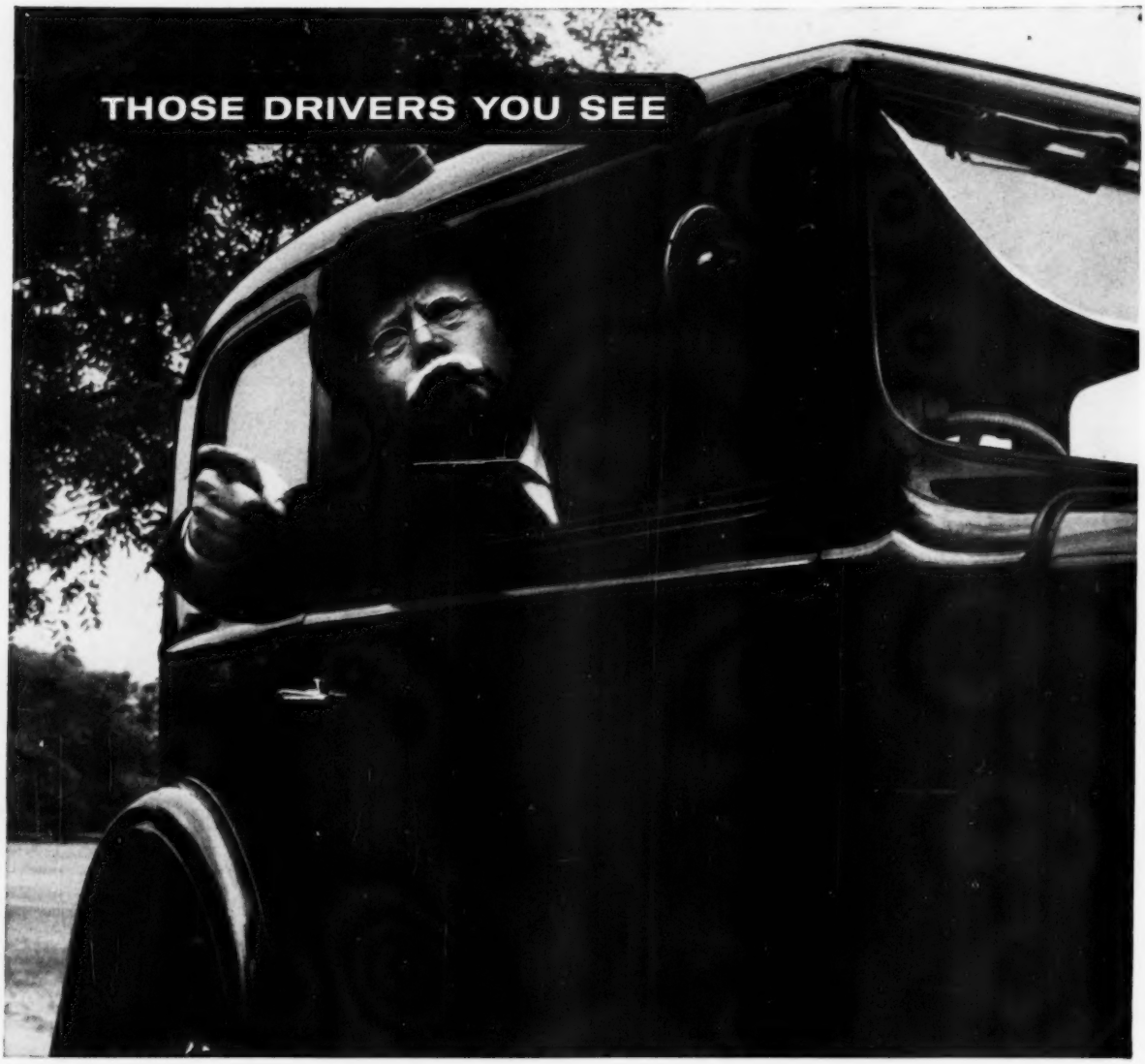
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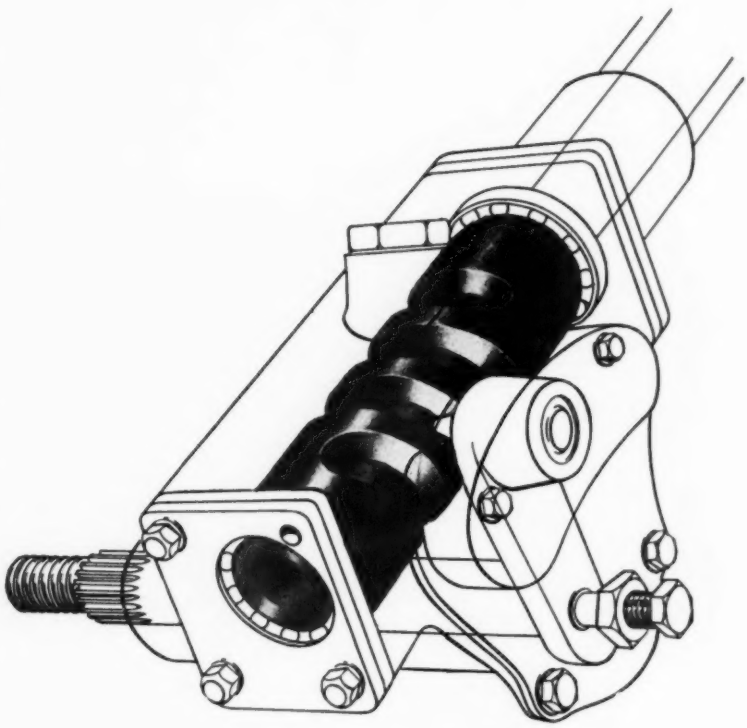
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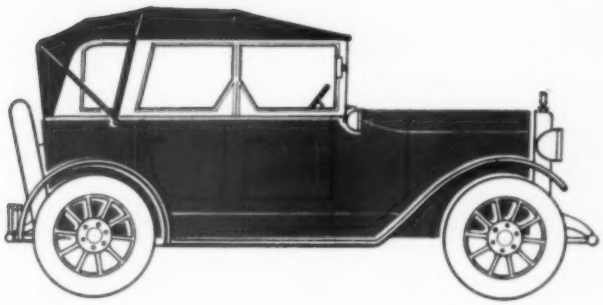
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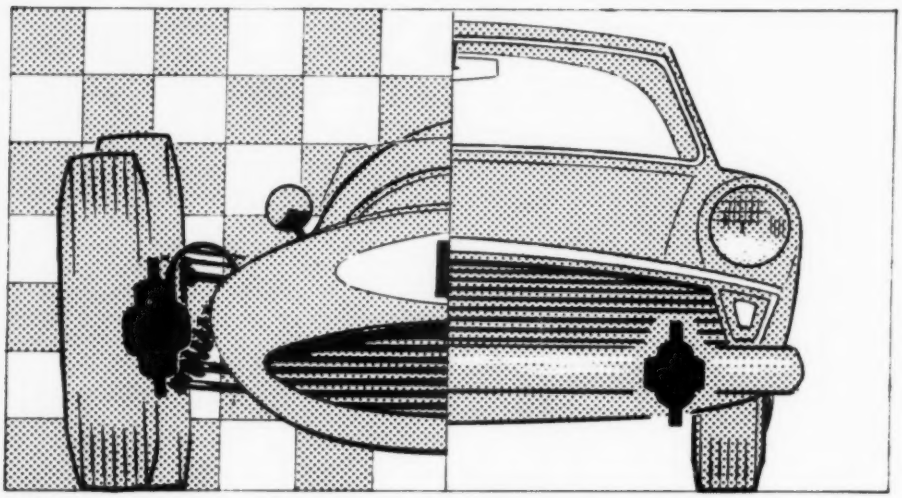
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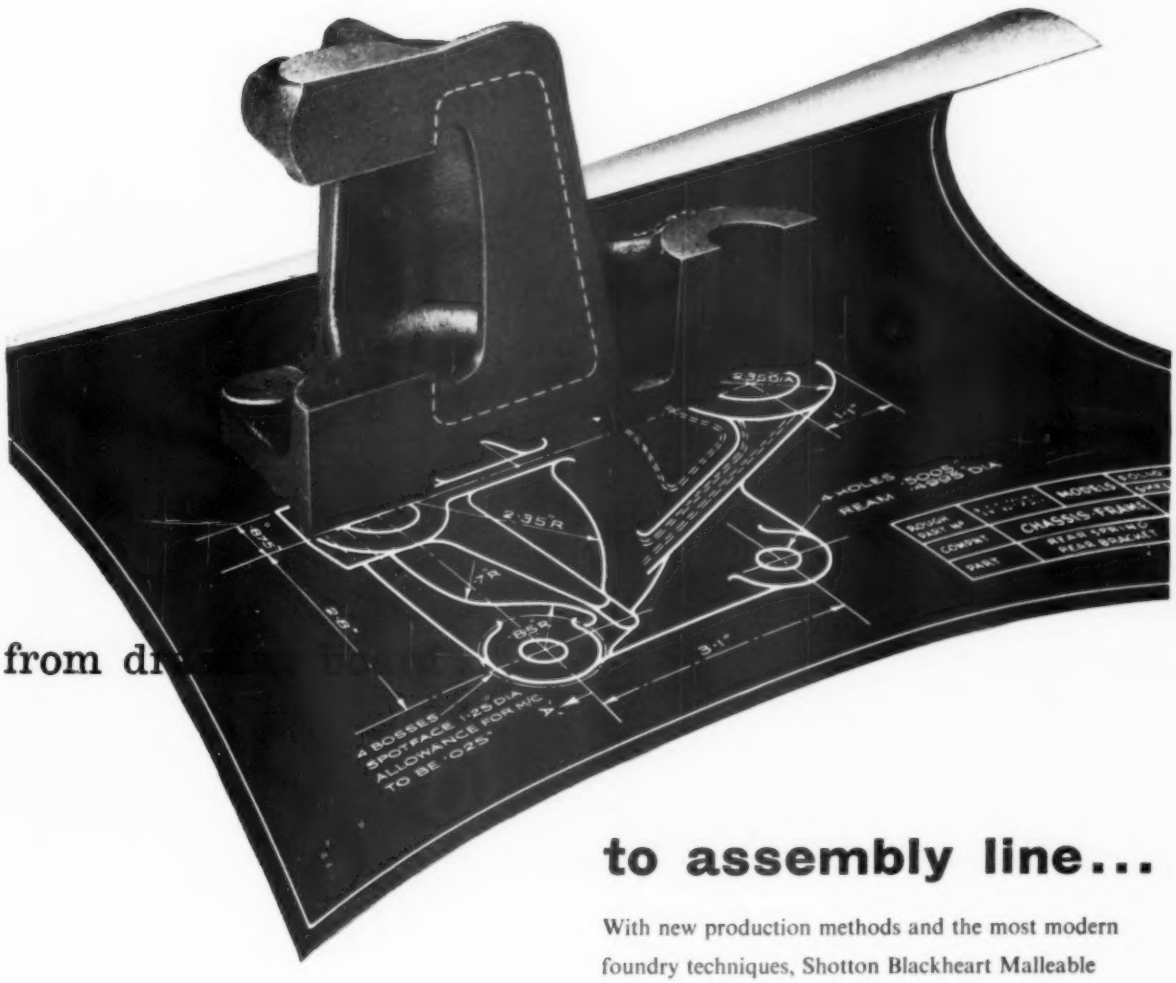
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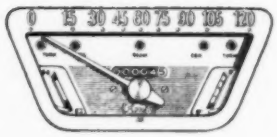


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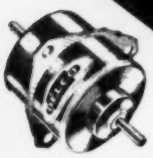
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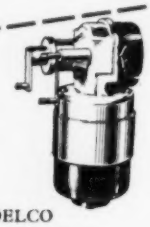
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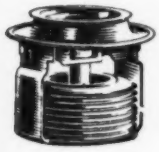
DELCO
Electric Screen Wipers



DELCO-REMY
Electric Horns

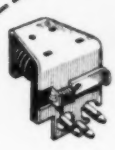


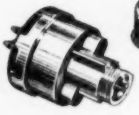
DELCO-REMY
Oil-Filled Coils



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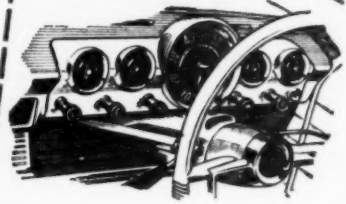




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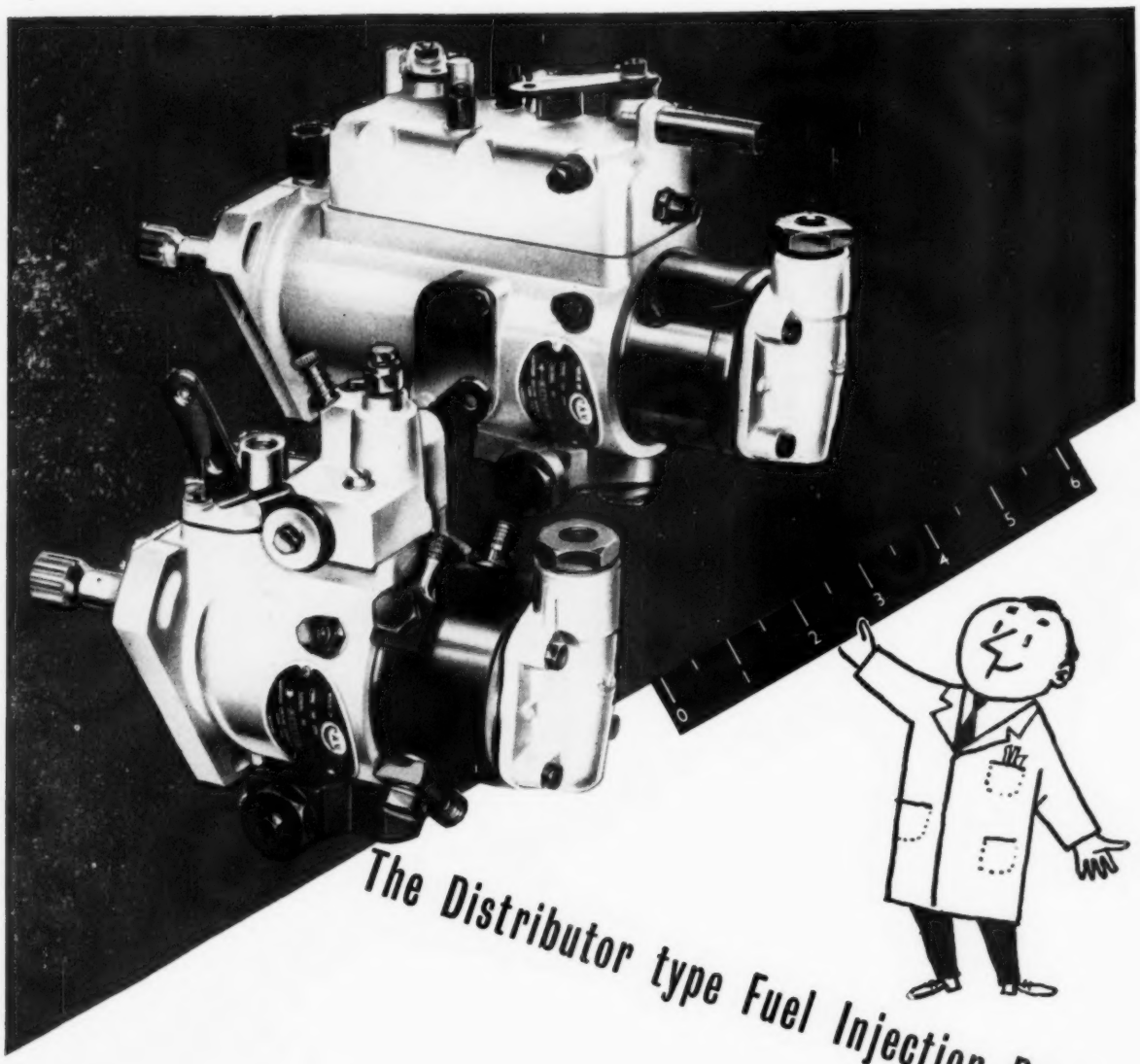
The Wrestlers, Florence Wyn

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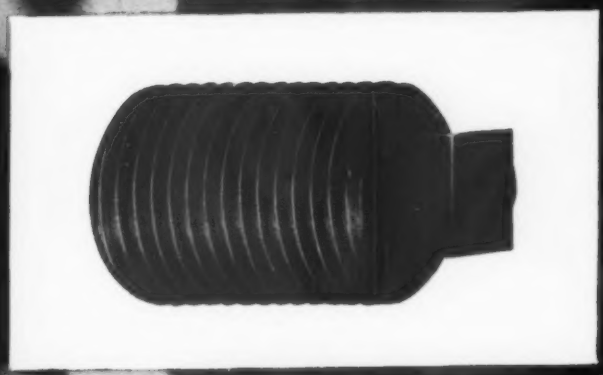
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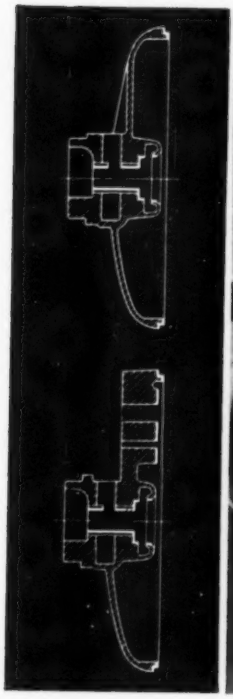
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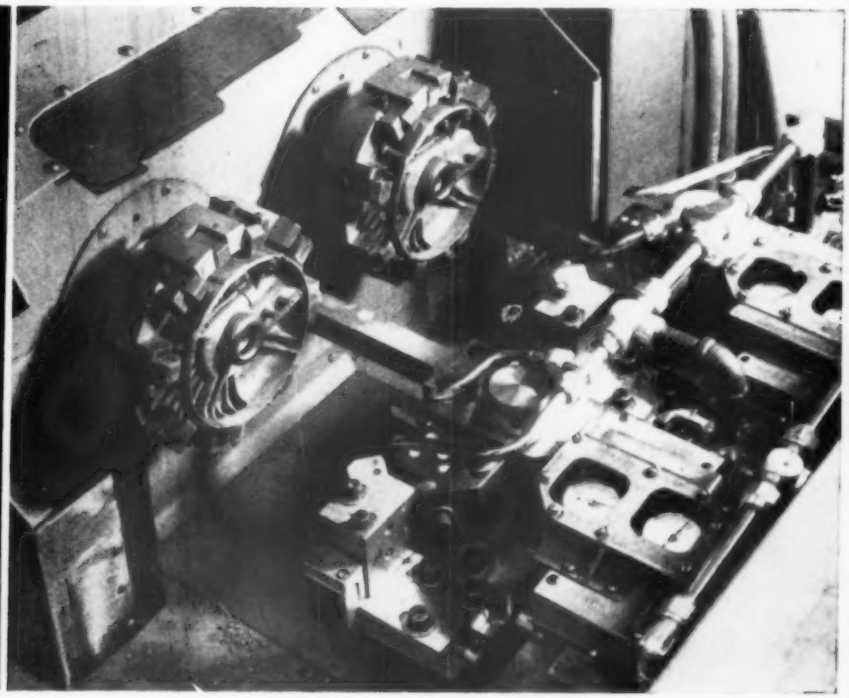
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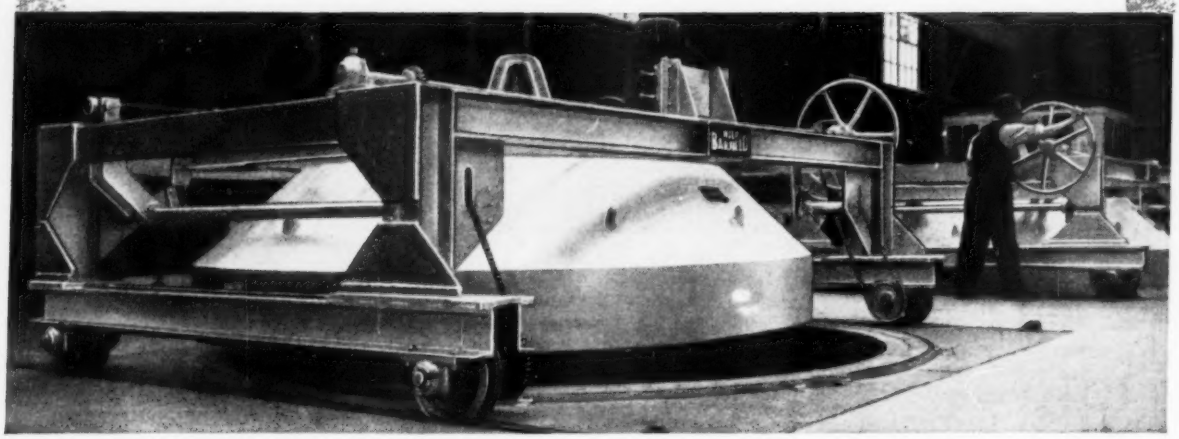
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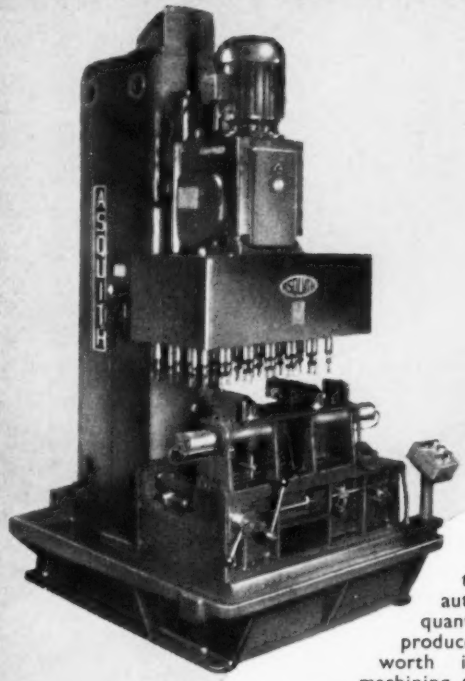
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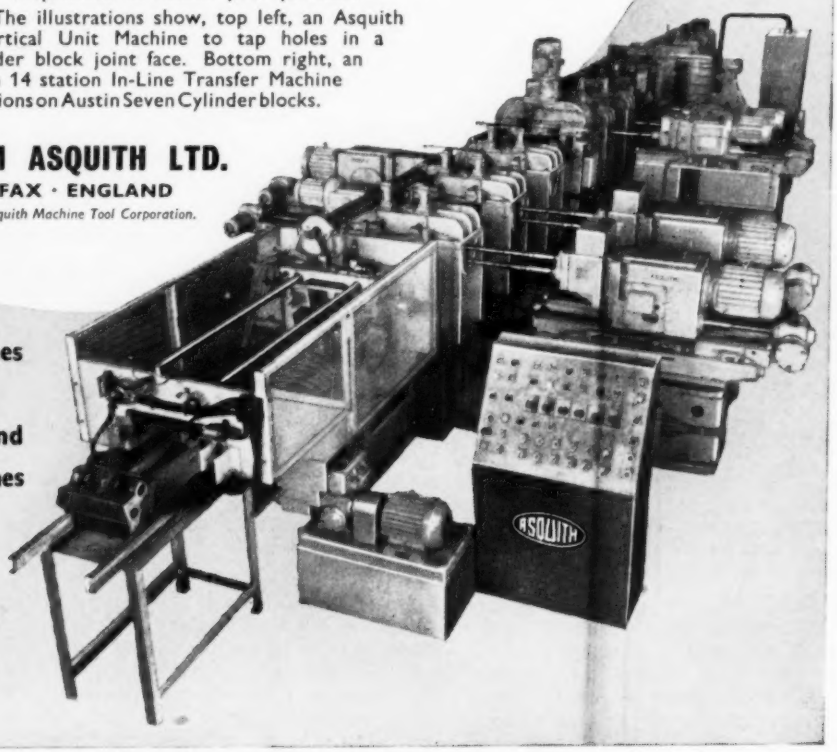
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The illustrations show, top left, an Asquith Vertical Unit Machine to tap holes in a cylinder block joint face. Bottom right, an Asquith 14 station In-Line Transfer Machine for operations on Austin Seven Cylinder blocks.

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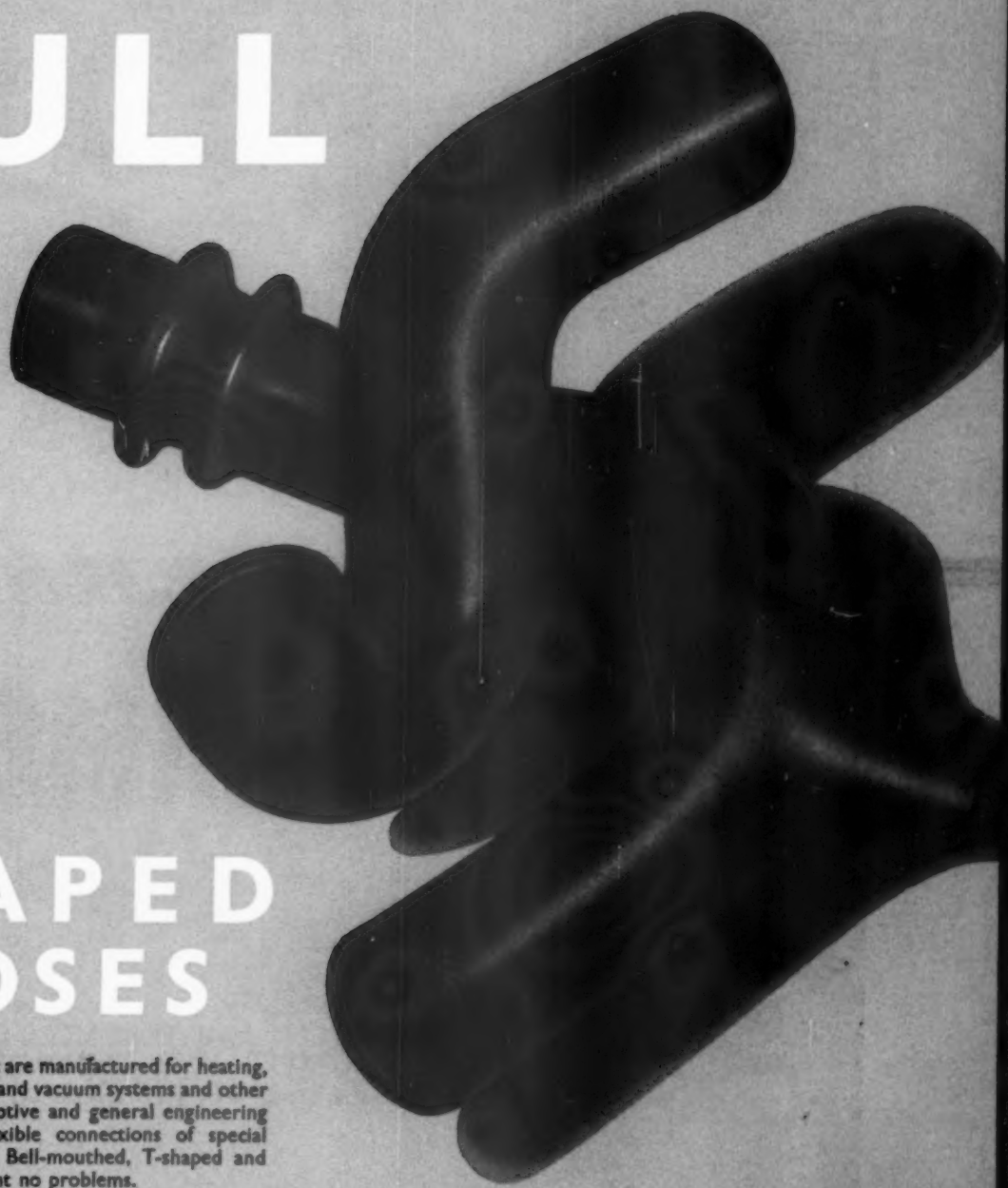
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JOHN BULL



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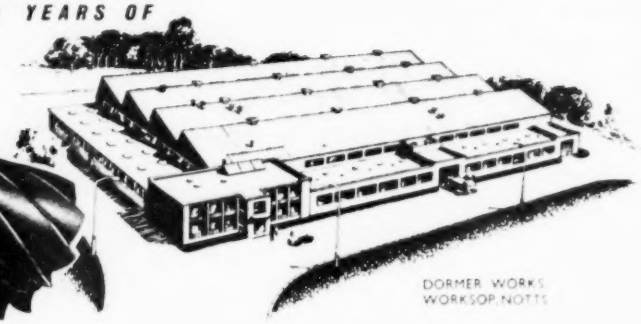
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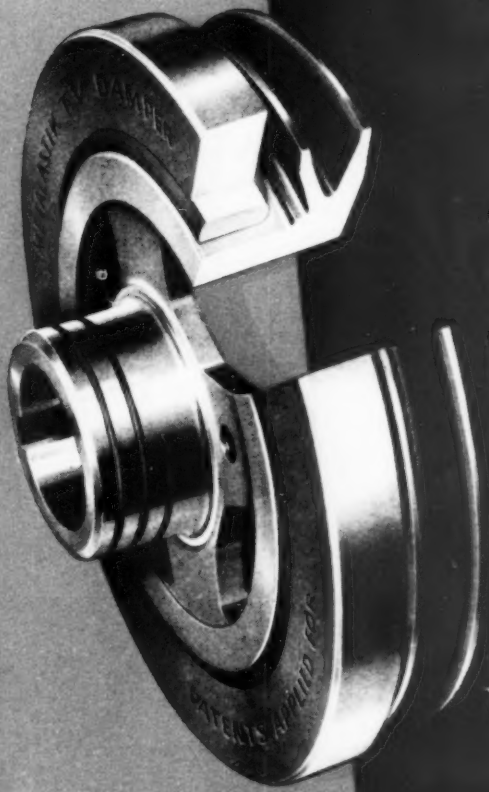
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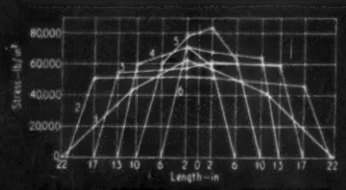
METALASTIK

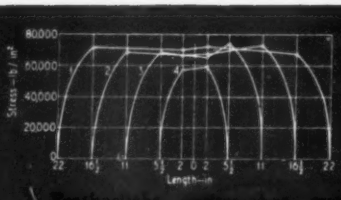
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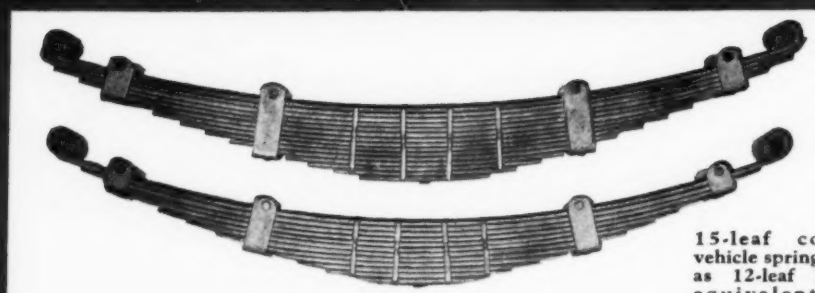
HOW TO SAVE SPRING WEIGHT WITHOUT INCREASING STRESS



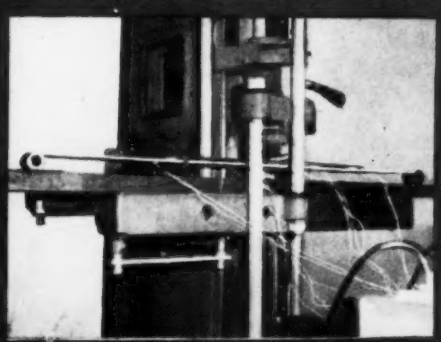
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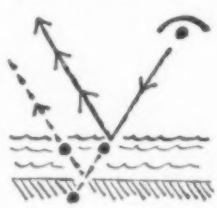
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TWS 81

Infra-Red Heating

Infra-red heating is the name given to the method of using in industrial processes radiant heat from heaters specifically designed for that purpose. This differentiates it from methods employing both radiation and convection, as in furnaces, although the effect of the radiation is much the same in both cases.

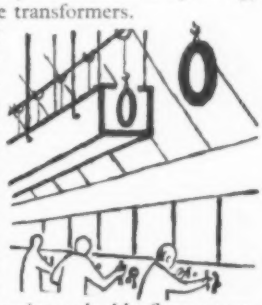
Radiant heat provides a higher rate of heat transfer to bodies not highly reflective than does convection, unless high-velocity forced convection is used. The rate of heating of a body depends upon the intensity of radiation on its surface, the proportion absorbed by the surface and, subsequently, on heat conduction. In heating very thin bodies, for example paint films, the radiation not reflected nor absorbed passes through and is in turn reflected or absorbed by the underlying material. This reflected heat is partly absorbed by the paint film "on the way back". Despite this effect it is an exaggeration to claim that infra-red "heats from the inside out" and it remains largely a surface heating effect except in a few special cases.



Infra-red heaters mainly use metal-sheathed elements in special reflectors, but infra-red lamps with internal reflectors are still used in special cases. Other types use silica-sheathed elements or quartz-sheathed lamps in reflectors. A wide range of heaters is available with simple mounting arrangements to enable heat to be applied quickly and effectively either in a production line or in some odd corner.

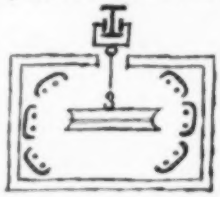
Control of the charge temperature is effected by regulating the heating time and power. In the case of a moving charge, this is done by adjusting the conveyor speed and the number of heaters in circuit, i.e., by adjusting the effective length of the oven. Some of the heaters may be controlled by energy regulators or adjustable transformers.

The advantages of infra-red heating over convection heating include reduced heating times, reduced floor space, lower installation costs, almost instant starting, ability to focus the heat, and flexibility in effective oven length. Infra-red ovens can often be mounted in the roof, saving valuable floor space. Infra-red heating is not generally favourable for heating large bodies of low heat conductivity.



Paint Stoving

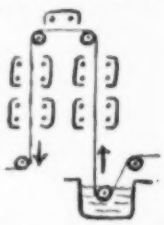
Not all paints are suited to infra-red radiation, but suitable paints are stoved quickly and often give a better finish. Synthetic enamels are the most suitable. Articles successfully stoved include motor car bodies, wheels and other accessories, refrigerator and washing machine cabinets, cylindrical drums and barrels, metal furniture, valve hand wheels, metal toys and a host of other articles. Lacquers and varnishes are being quickly and effectively stoved on jewellery, packing strips, tubes, films and similar products. Special infra-red lamp ovens stove synthetic finishes on wooden furniture and components. In all cases stoving times have been reduced very considerably.



Moisture Extraction

Sheathed element heaters are particularly useful for drying surface water films, their radiation being readily absorbed by water. High rates of drying are possible provided the water vapour can readily disperse. Drying of "contained" water can be effected provided the water can diffuse from the interior at a rate equalling the surface drying rate. With heat-sensitive materials sheathed element heaters may have to be arranged to move away from the material to avoid overheating if the conveyor stops, being interlocked with the conveyor for this purpose. Lamps are sometimes used instead for such materials because of their instantaneous cut-off.

Infra-red is widely used for drying coatings and inks on paper and textile products, bottle seals and labels, clayware and glazes, pigments on leather and many other products.



Plastic Heating

Infra-red heating is widely used in the plastics and allied industries. Typical applications are the preheating of plastic pellets and of sheets prior to moulding, curing of plastic and rubber sheets and belts, heat setting of nylon and similar fabrics, drying and curing of latex films on carpets and many others where a plastic forms the whole or part of the product.

The above are just a few examples of successful applications of infra-red. In many other processes infra-red heaters can often be fitted quickly and cheaply, to save time, labour and floor space and, therefore, money.

For further information, get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London W.C.2. Telephone: TEMple Bar 9434.

Excellent reference books on electricity and productivity (8/6 each, or 9/- post free) are available — "Resistance Heating" is an example; "Induction and Dielectric Heating" is another.

E.D.A. also have available on free loan in the United Kingdom a series of films on the industrial uses of electricity. Ask for a catalogue.

8181

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Photograph by courtesy of Ford Motor Company Ltd.

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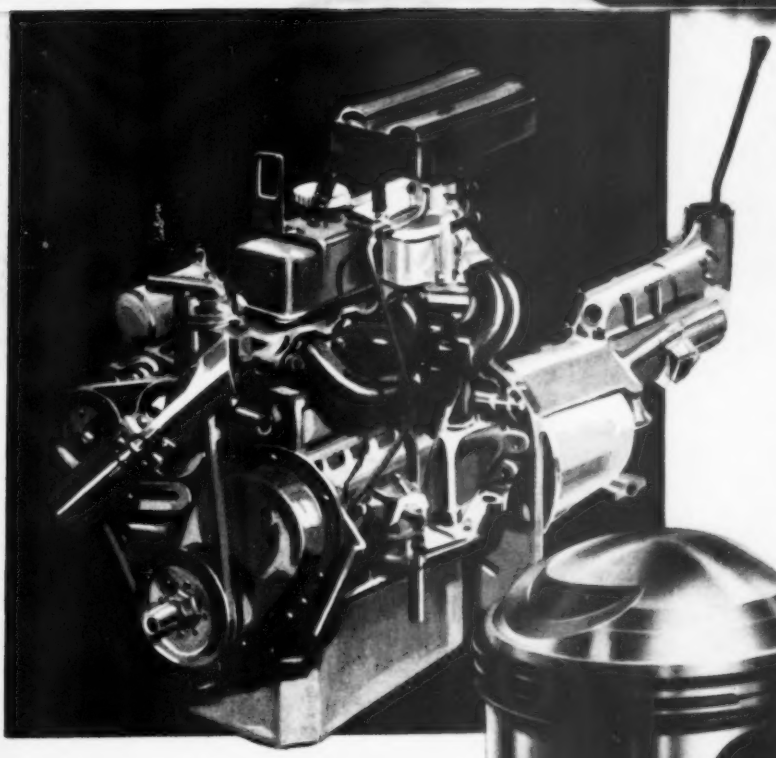
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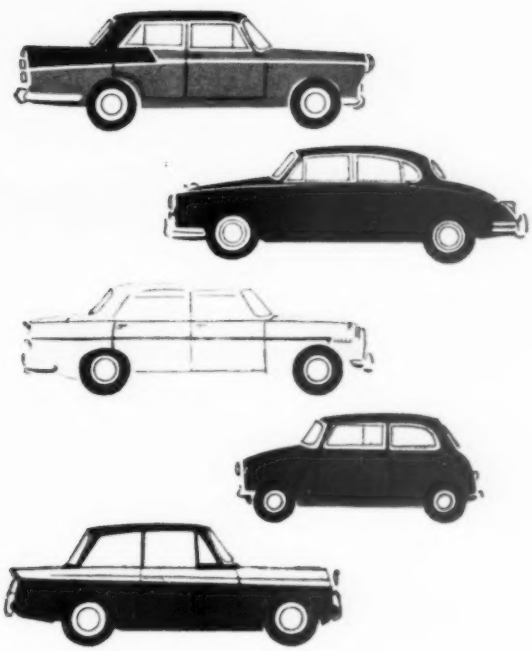
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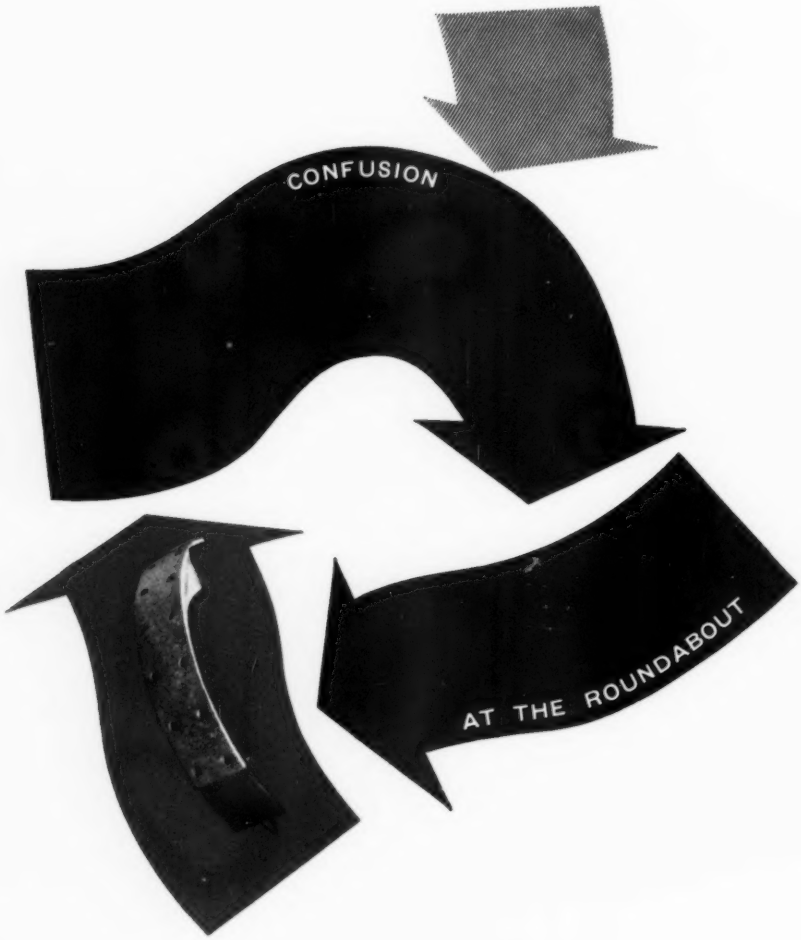


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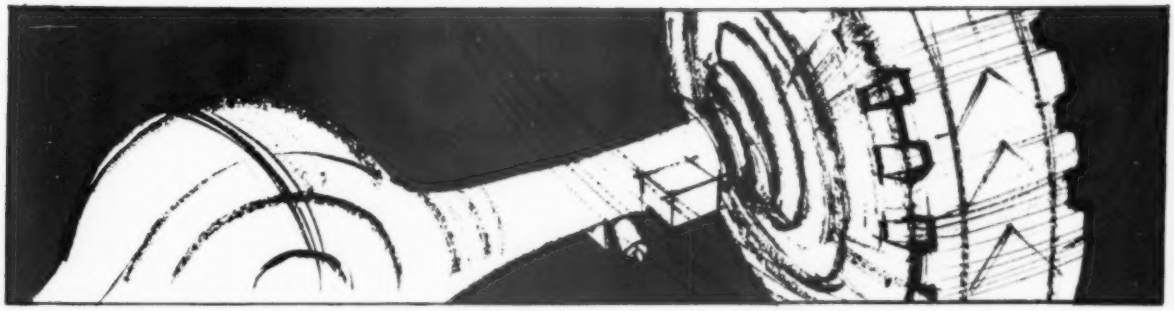
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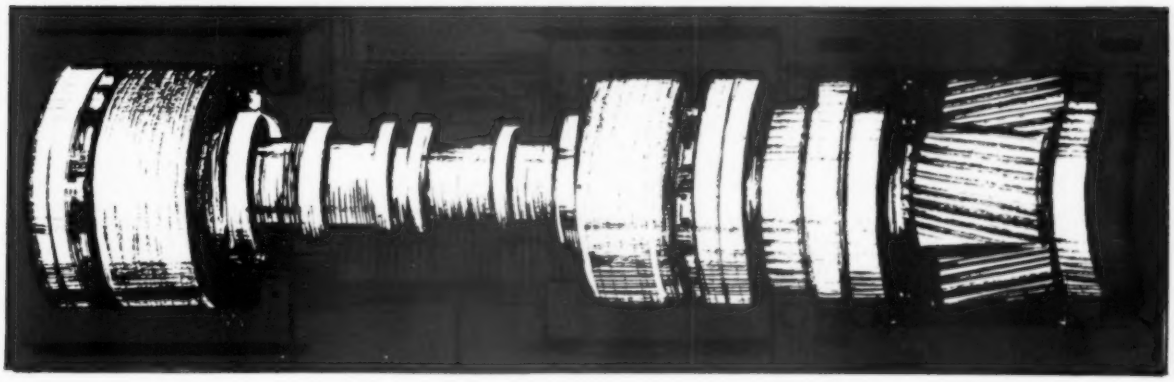
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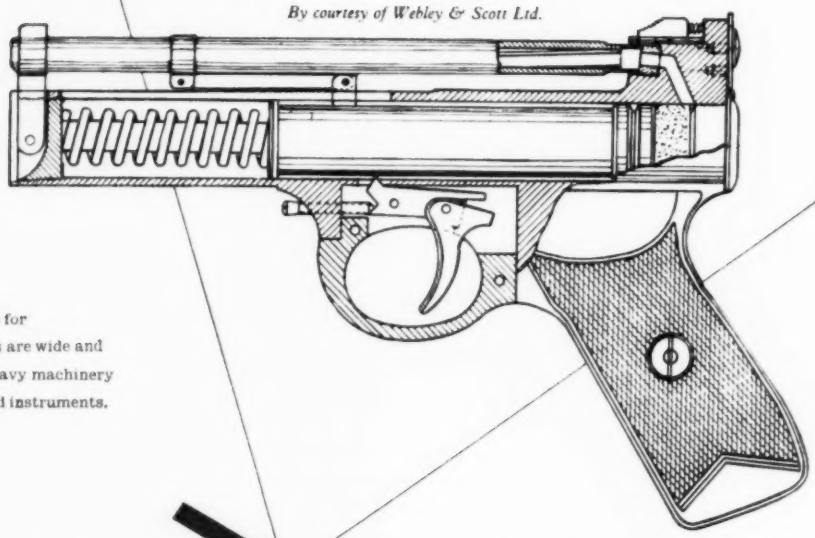
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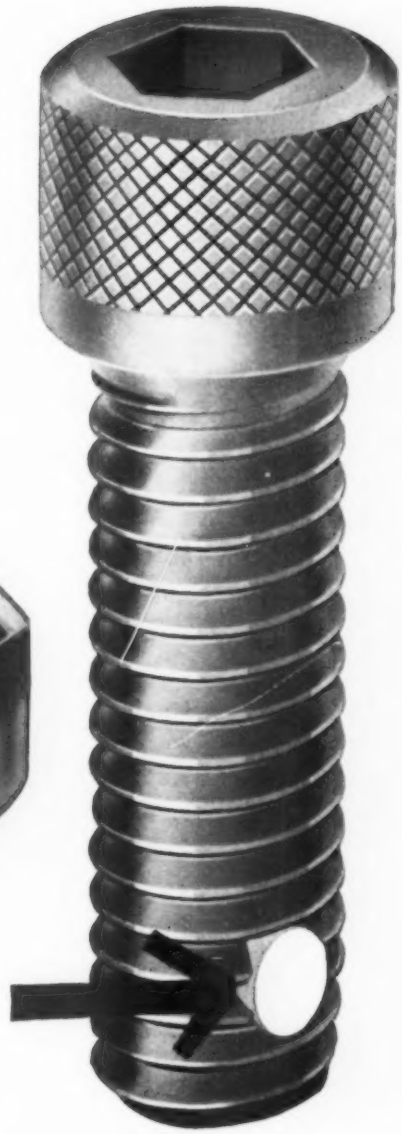
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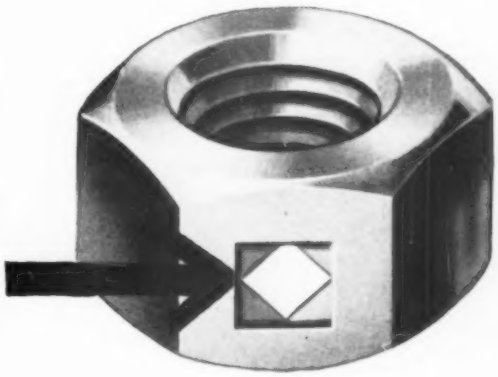
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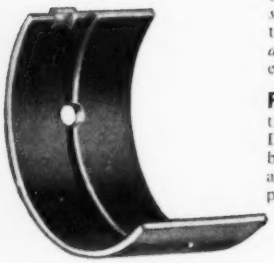
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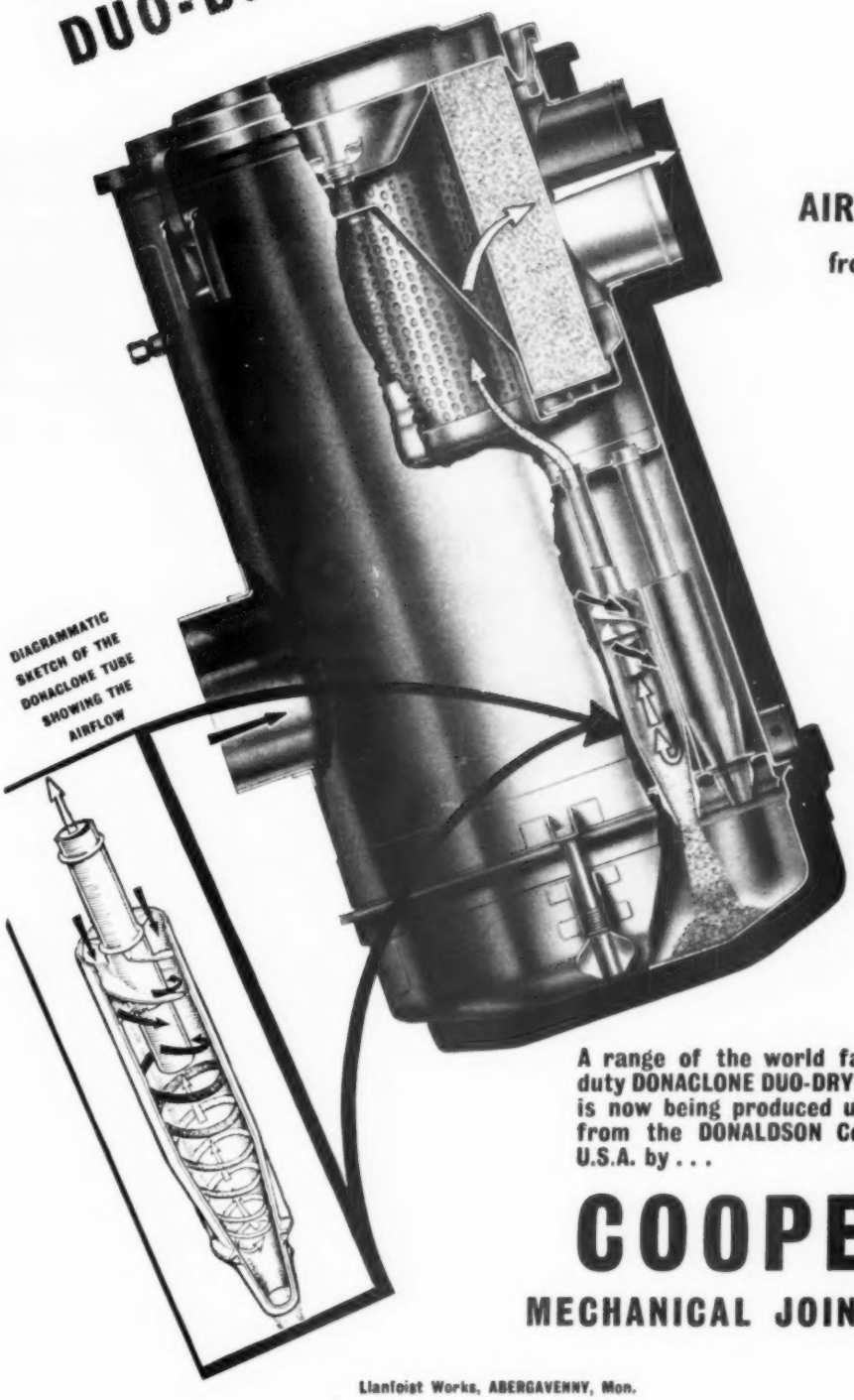
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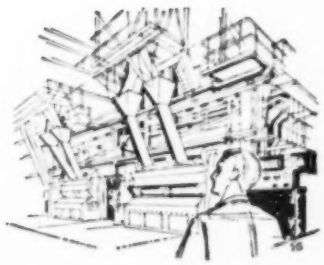
of heat under the 4 giant boilers in the impressive powerhouse. The fuel is coal—chosen by the directors for reasons of convenience, economy and reliability. The choice is a wise one, for coal, mechanically stoked, is smokeless, and produces more heat for the money than any other fuel. Furthermore, the coalfields of Britain can supply all the fuel our industries will need for scores of years to come.

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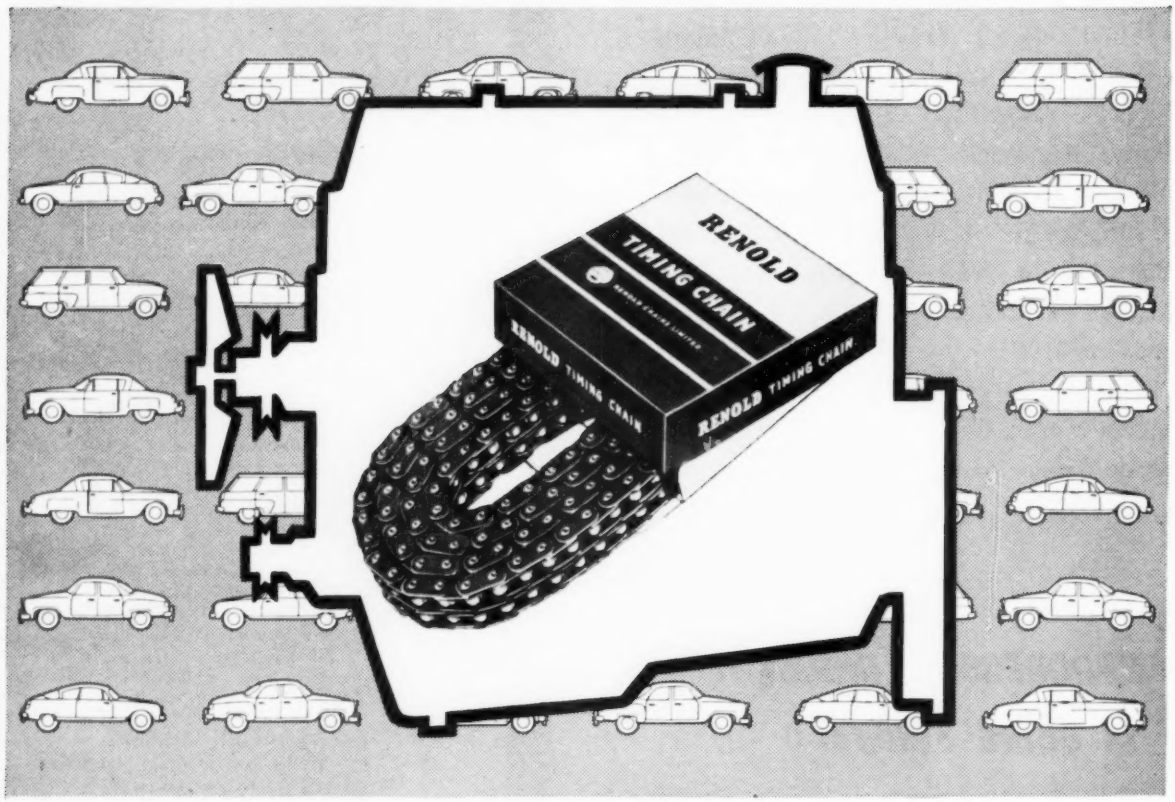
We at Singer choose coal because it meets all our fuel requirements."

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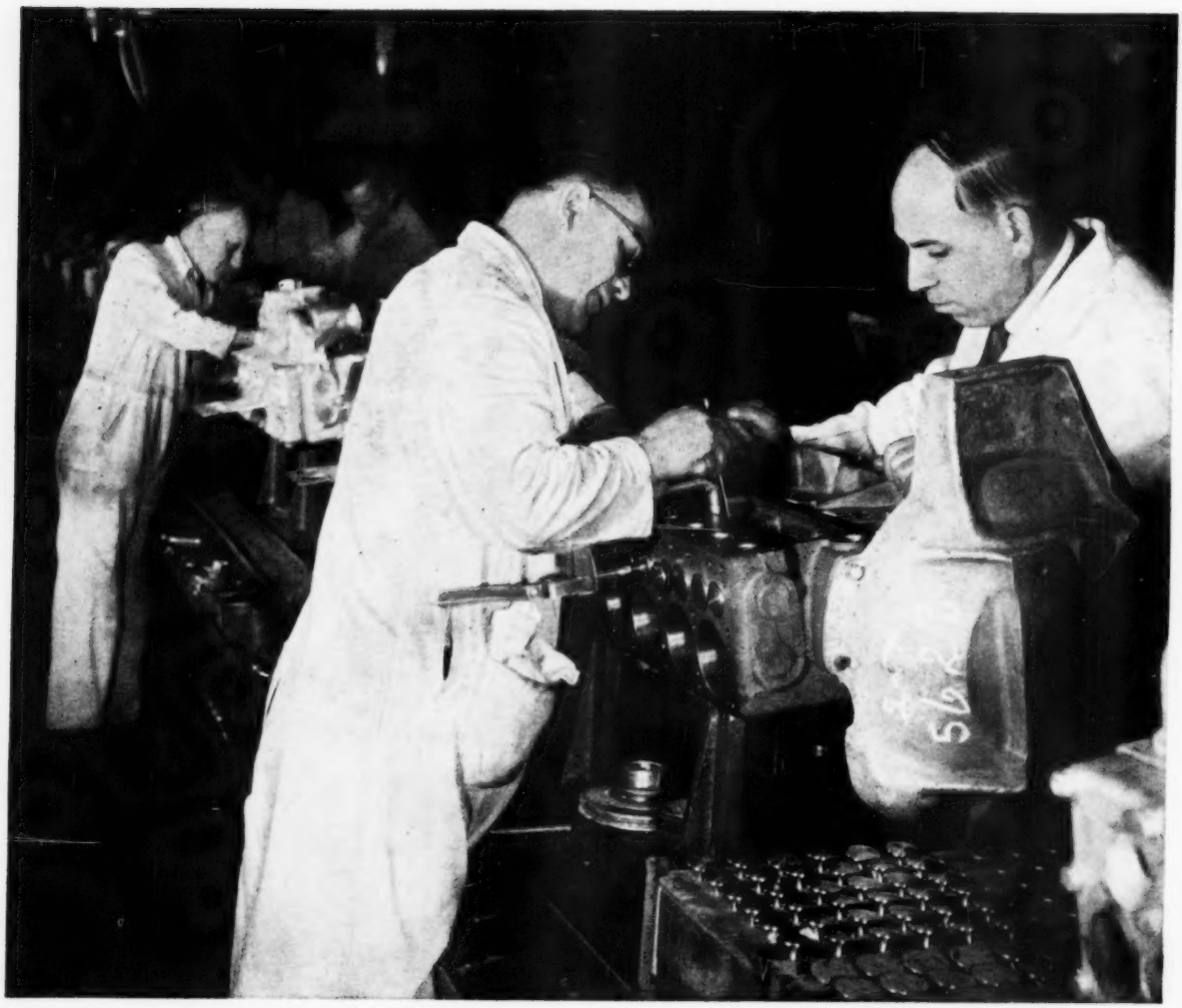
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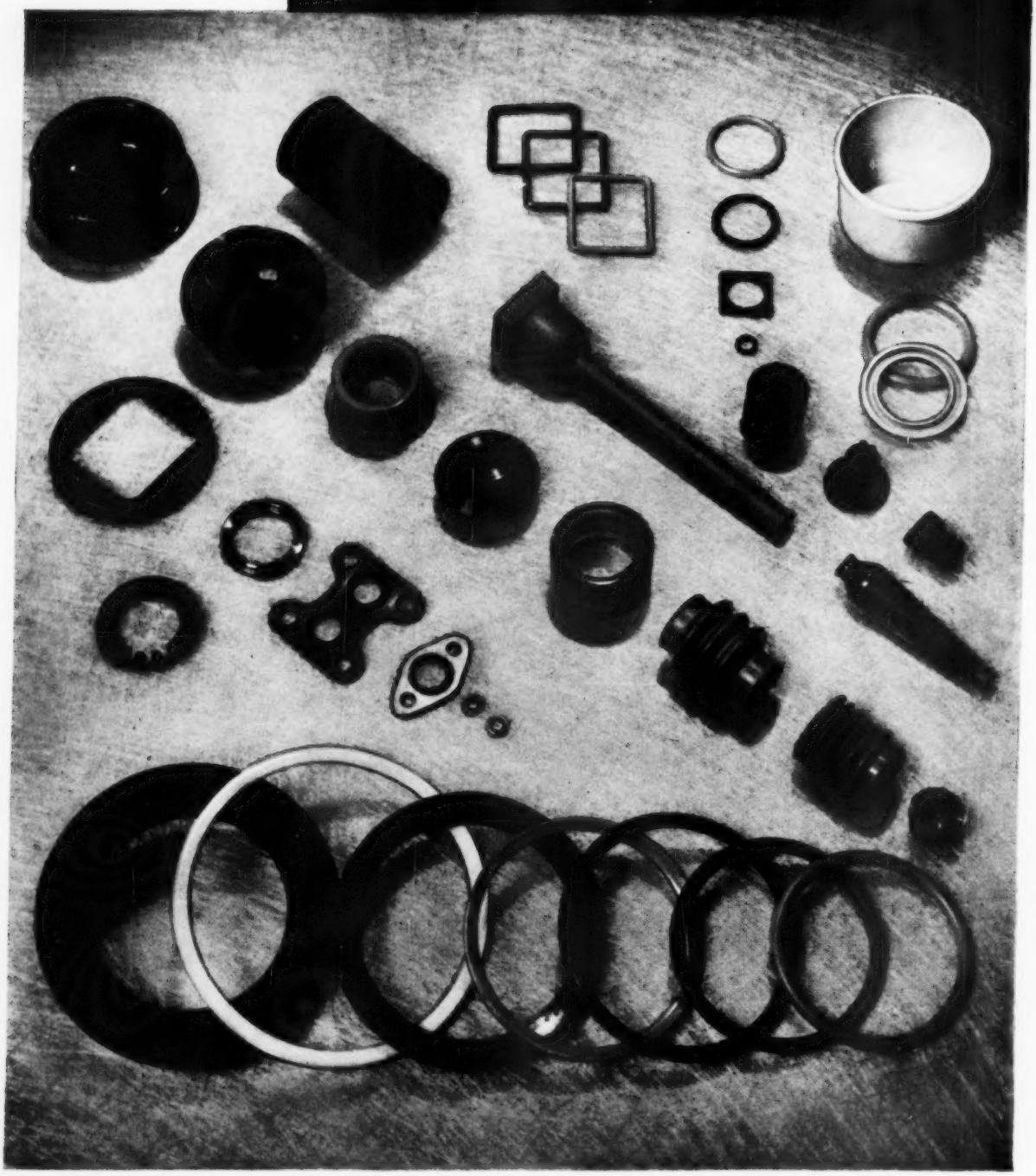
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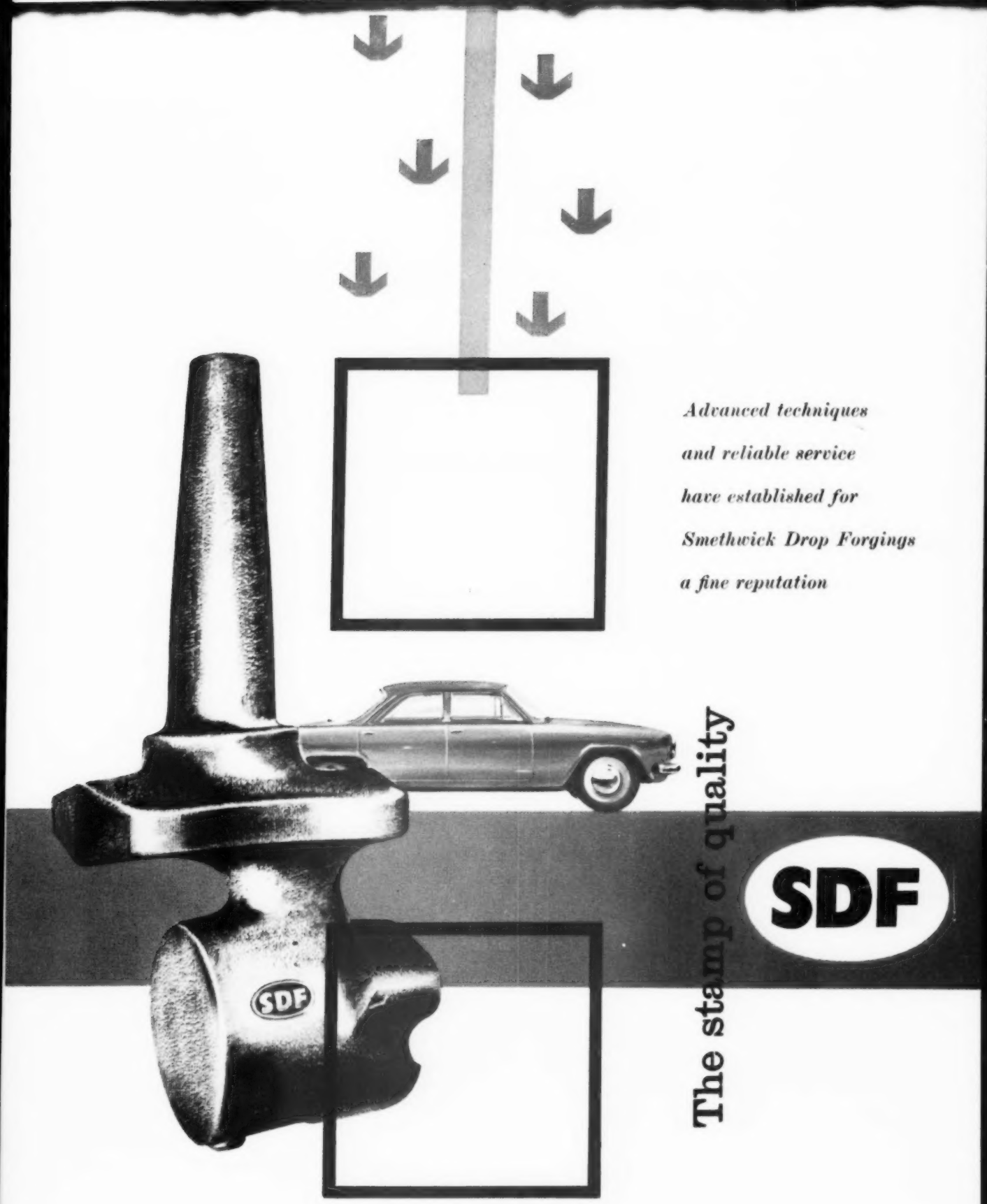
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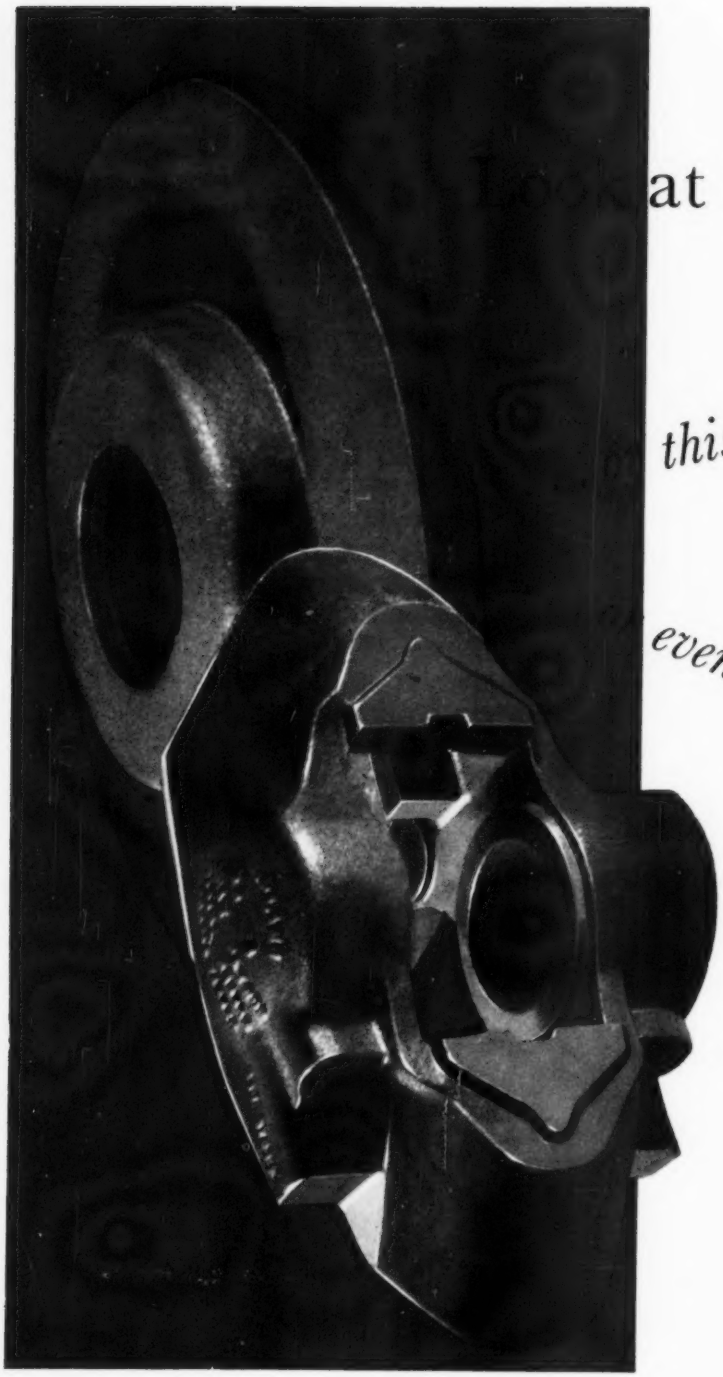
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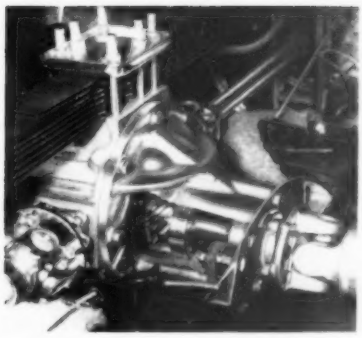
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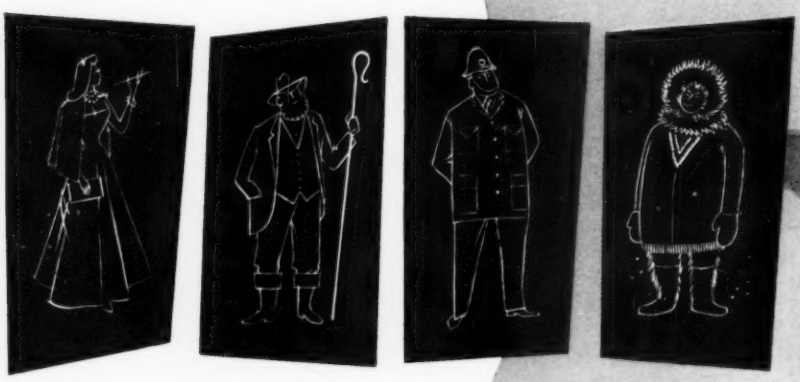
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DESIGN MATERIALS **AUTOMOBILE ENGINEER** PRODUCTION METHODS WORKS EQUIPMENT

Forward with Computers

As a result of spectacular progress in the development of electronic computers, and of their ever-widening fields of application, some of the new lines along which the automobile industry will now have to advance are clearly apparent. Indeed, it was because of the rapidly expanding demand for information on this and other types of equipment for handling rapidly the vast quantities of data that must be dealt with in administrative and technical departments that our associated journal *Data Processing* was brought into being.

A good example of the kind of work that can be done by computers is given in a paper entitled "Analysis and Simulation of Automobile Ride", by R. H. Kohr, presented before the Society of Automotive Engineers in March 1960. Although the solution of suspension problems, taking into account factors such as the complex characteristics of dampers and spring rate variations due to geometry and rubber bushes, is too complex to be done by normal mathematical methods, it is by no means difficult by simulation with an analogue computer. By using an input in the form of a tape recording of road disturbances, the response of the suspension to alterations in variables, such as damper setting, can be readily observed. So far as vehicle development is concerned, a system of this type is most useful since the actual, as distinct from the calculated, characteristics of the suspension can be supplied, through the medium of transducers, to the computer. In the British automobile industry, digital computers are being used for the organization of spare parts distribution and stock control; with regard to the latter, it seems likely that the associated cost accounting and the estimation of overtime needed in different departments to meet the requirements of the assembly lines could also be done.

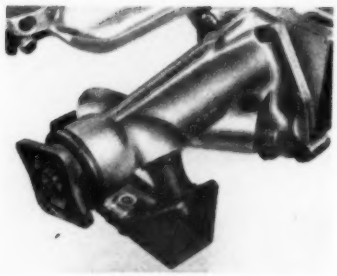
The automobile industry, in its assessment of the value of computers in motor vehicle design, production and factory administration, is of course having to estimate what the benefits are, in respect of reduced overall costs and improvement of the product. Because of the extremely high cost of the equipment, it obviously cannot be accepted unless the benefits are proved to be considerable. There are two ways in which computers can be of value. One is by effecting speedily and accurately the tedious and repetitive elementary calculations that otherwise would have to be done by a large clerical department—for example, for the preparation of pay rolls or for stock control. The second is by undertaking for design, research and other departments calculations that hitherto have been out of question because of either their complexity or the length of time that would be required for their completion by conventional methods.

In purely administrative applications, the cost savings can be estimated fairly accurately, at least so far as the performance of existing tasks is concerned—this of course is simply a matter of comparing the overheads and salaries of the clerical department already employed with those of the computer and the staff needed to operate it. However, a simple comparison does not give the whole story: by the use of the computer, work that would have taken perhaps a whole week can be done in a matter of an hour or two, and thus economies can be effected by virtue of the fact that those in control are given an up-to-the-minute picture of the situation, for example, in respect of stock-in-hand or fluctuations in sales demands. A particularly useful feature is that computers can be set to reject all except the information, such as departures from a planned programme, that is necessary to management: thus the task of administration and control is simplified.

With regard to application to design and research, that benefits can be obtained by the employment of a computer is undisputed, but their exact value may be difficult to assess. This is partly because of the impossibility of estimating the value, so far as sales are concerned, of technical improvements in design, but mainly because computers will undoubtedly be used for work which, for reasons already explained, is completely outside current experience. In fact, the key to success with computers in vehicle design, as well as research, lies in application in these hitherto unexplored fields.

Recruitment of programmers is a major problem. The need is for an approach by minds capable of clear analytical thought and untrammelled by preconceived notions as to how the work should be organized: the men must be capable of a high degree of concentration on detail, while retaining, nevertheless, a balanced view of the overall aspects of the problems. They are usually to be found among graduate mathematicians, accountants and engineers. It is sometimes difficult to obtain suitable people from among a firm's existing staff, since the other departments are loath to release their really first class men. However, if the programmers are selected as candidates for subsequent promotion to general management, recruitment might be easier. It must of course be borne in mind that a computer is simply a machine for the performance of calculations with extreme rapidity, and the limiting factor in its use is the ability of its programmers.

Triumph Herald



Part 11: The Transmission, Rear and Front Suspension Systems, Steering Gear, Brakes and Electrical Equipment

As in the case of the engine, the gearbox of the Herald is generally similar to that of the Standard Eight car described in the July 1954 issue of *Automobile Engineer*. There are, however, sufficient differences to warrant a reproduction here of the general arrangement drawing. The gearbox ratios and the details of the gears themselves are unchanged.

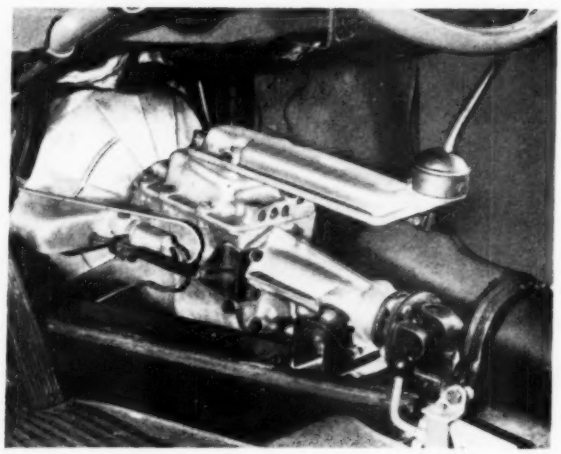
Hydraulic actuation of the clutch is retained, the slave cylinder being housed on the left of the gearbox. However, the carbon thrust ring employed in the actuating mechanism of the earlier car is replaced by a ball throw-out bearing. This bearing, which is of Hoffmann manufacture, has a lipped outer race and a half-cage for the balls; its outside diameter is $2\frac{3}{8}$ in. In the accompanying reproduction of the general arrangement drawing of the gearbox are shown this bearing and a second type that was previously fitted as an alternative.

A feature of the Standard Eight car was the use of an integral clutch housing and gearbox shell of DTD 424 aluminium alloy. On the earlier Herald models, a casting of similar design was used, but a change has recently been made to a separate cast iron shell for the gearbox; the clutch housing remains an aluminium casting. The alteration has increased the rigidity of the assembly and has thereby reduced the transmission of noise.

The support for the front end of the mainshaft in the primary shaft has been changed from a Clevite 10 bush to a Torrington needle roller bearing. Twenty rollers, measuring $\frac{1}{12} \times \frac{5}{8}$ in diameter are employed; they run directly on the mainshaft, which has a nominal diameter of $\frac{1}{2}$ in at this point. Although the diameter of the primary shaft counterbore is larger than before, the high load-carrying capacity of the Torrington component has permitted a reduction in bearing length. In this way, an adequate thickness of metal has been retained between the counterbore and the external shoulder on which is fitted the inner race of the primary shaft bearing.

A feature of the original Standard Eight gearbox was the rather complex system to ensure adequate lubrication of the bushes of the mainshaft and layshaft clusters. This system involved the passing of oil from a well in the extension casing, along the layshaft—by way of a drilled passage at each end and an external helical groove, which lubricated the bushes between these passages—to a vertical drilling in the front cover. Thence it was fed, through further drillways, both to the mainshaft bush in the primary shaft and to the bores of the fully floating bush on which the second and third gear pinions revolved. This bore was helically grooved for distribution, and radial holes led the oil to the periphery of the bush, which also had a helical groove.

On the Triumph Herald gearbox, the method of lubricating the layshaft bushes, from the rear well, is unchanged, but the rest of the system has been simplified. Clearly, no special provision is required to lubricate the needle roller bearing that replaced the bush in the primary shaft, so the oilways have been deleted in the leading end of the layshaft, the front cover and the primary shaft and mainshaft. As a result, it was necessary to introduce a means of getting oil to the mainshaft floating bushes. For this purpose, radial holes are drilled in the gear blanks from their bores to the roots of their teeth, in the conventional way. The bushes have radial slots at each end, to bring the oil to their bores, and the oil is distributed over the bearing surfaces by internal and external helical grooves. It will be apparent that these modifications will have effected some reduction in production costs.



Top: The rear extension of the Herald gearbox is supported on two inclined rubber bobbins. Above: A neat remote control mechanism is mounted on top of the gearbox; the lever is very conveniently sited

A major alteration to the design concerns the gear change control mechanism. Whereas on the Standard Eight, and the subsequent Ten and Pennant models, a ball-jointed lever of medium length acted directly on the selector forks, the Herald is fitted with a remote-control system, giving a more convenient lever position, a shorter travel and more precise control. In essence, the control mechanism consists of a short gear lever and a longitudinal link, which extends forward from the lower end of the lever to the striker shaft of the gearbox.

Bolted to the top cover of the gearbox shell, and projecting rearward from it, is the aluminium casting that houses the linkage; the main portion of the casting is of inverted channel section. At its rear end is machined a part-spherical socket, in which fits an oil-resistant, nylon part-ball pressed on to the lever. The length of the lever, from the top of the knob to the centre of the ball joint, is 9 in.

To the spade-shape lower end of the lever is pinned the forked rear end of a longitudinal steel rod, which is situated within the channel of the housing. The leading end of the rod is flattened and drilled to accept the outer sleeve of a bonded rubber bearing; the axis of the bearing is vertical in the neutral position. By means of a through-bolt, the

inner sleeve of the bearing is clamped between the jaws of a forked member, which fits on the rear end of the striker shaft and is retained by a spring tension dowel. The purpose of connecting the rod to the striker shaft through a resilient bearing is, of course, to accommodate angularity between their axes resulting from movement of the lever. Excessive flexibility is avoided by the fitting of fibre washers between the jaws and the ends of the rubber bush.

The striker shaft, of $\frac{1}{2}$ in diameter, is carried directly in the remote control housing, in which it is free to rotate or slide axially. Oil seepage through the shaft bearings is prevented by an O-ring in a groove in each. Clamped to the shaft by a square-headed, taper set screw is the striker arm, an En.32B steel stamping. The ball end of the arm is hardened, and it engages the selector forks in the conventional manner.

On the Standard Eight unit, the cast aluminium rear extension of the gearbox embodied a lug on top, which housed the bonded rubber rear mounting bush. Instead of this lug, the Herald casting has two faced bosses, one on each side, which are drilled and tapped to take the attachment studs of a pair of Metalastik bonded rubber bobbins. The bosses are disposed symmetrically below the horizontal plane through the mainshaft axis, towards the rear of the extension; their axes intersect at a transverse included angle of 90 deg.

On the early Standard Eight and Ten models, the transmission sliding coupling was carried on splines at the rear of the mainshaft, and was supported in the extension on two bronze bushes. Subsequently, the sliding coupling was embodied in the propeller shaft, a fixed flange being fitted to the mainshaft. Since the final-drive unit of the Herald is mounted on the sprung portion of the vehicle, a splined coupling is not necessary. Consequently, the coupling flange is pressed on to a short splined section at the tail end of the mainshaft, clamping the inner race of a $1\frac{7}{8}$ in outside diameter ball bearing against a distance sleeve, which in turn abuts against a shoulder on the shaft. The outer race of the bearing is pressed into the extension casting.

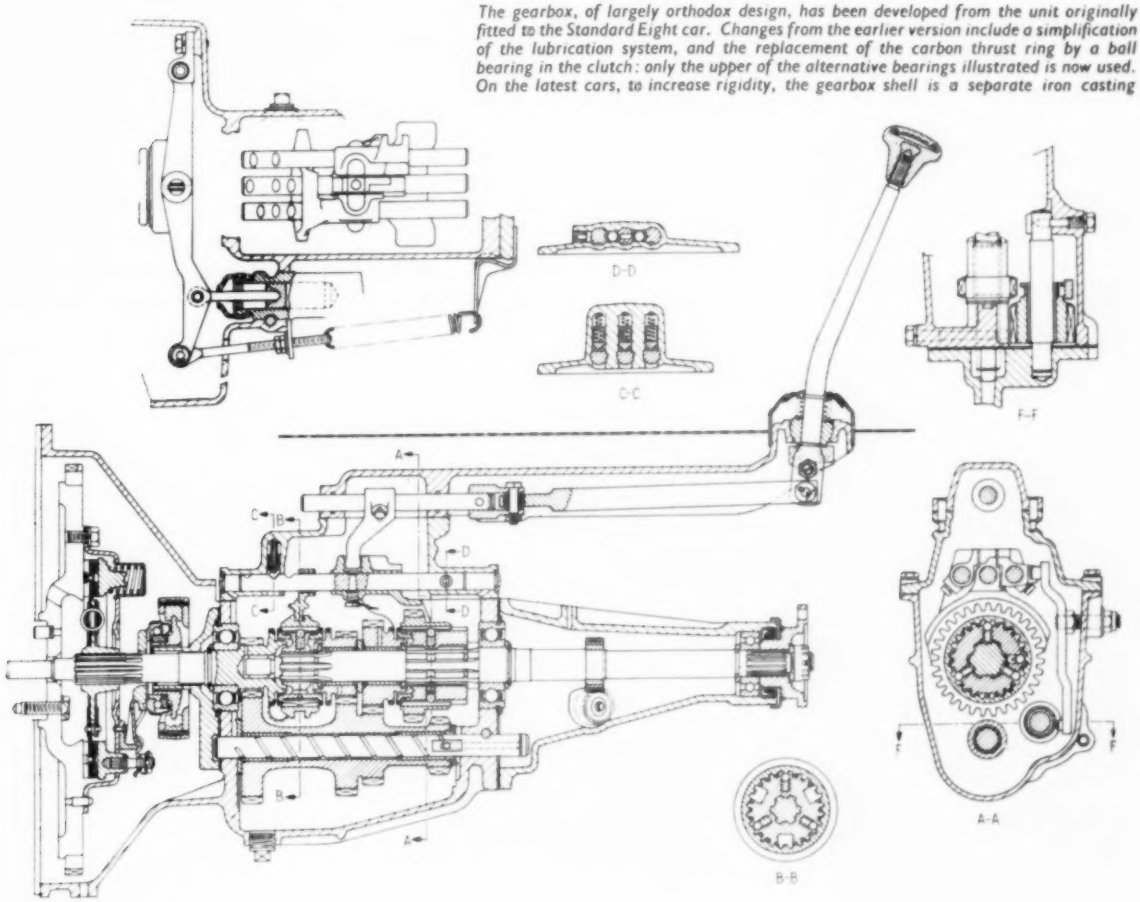
Rearward of the bearing is a lip type oil seal, the housing of which is also a press fit in the extension; the seal bears on the periphery of the flange boss. A castellated nut and a split-pin secure the flange on the shaft. The nylon skew gear for the speedometer drive is now sited $2\frac{1}{4}$ in behind the rear joint face of the gearbox shell, whereas on the Eight it was immediately behind the rear bearing of the mainshaft.

Propeller shaft and final-drive unit

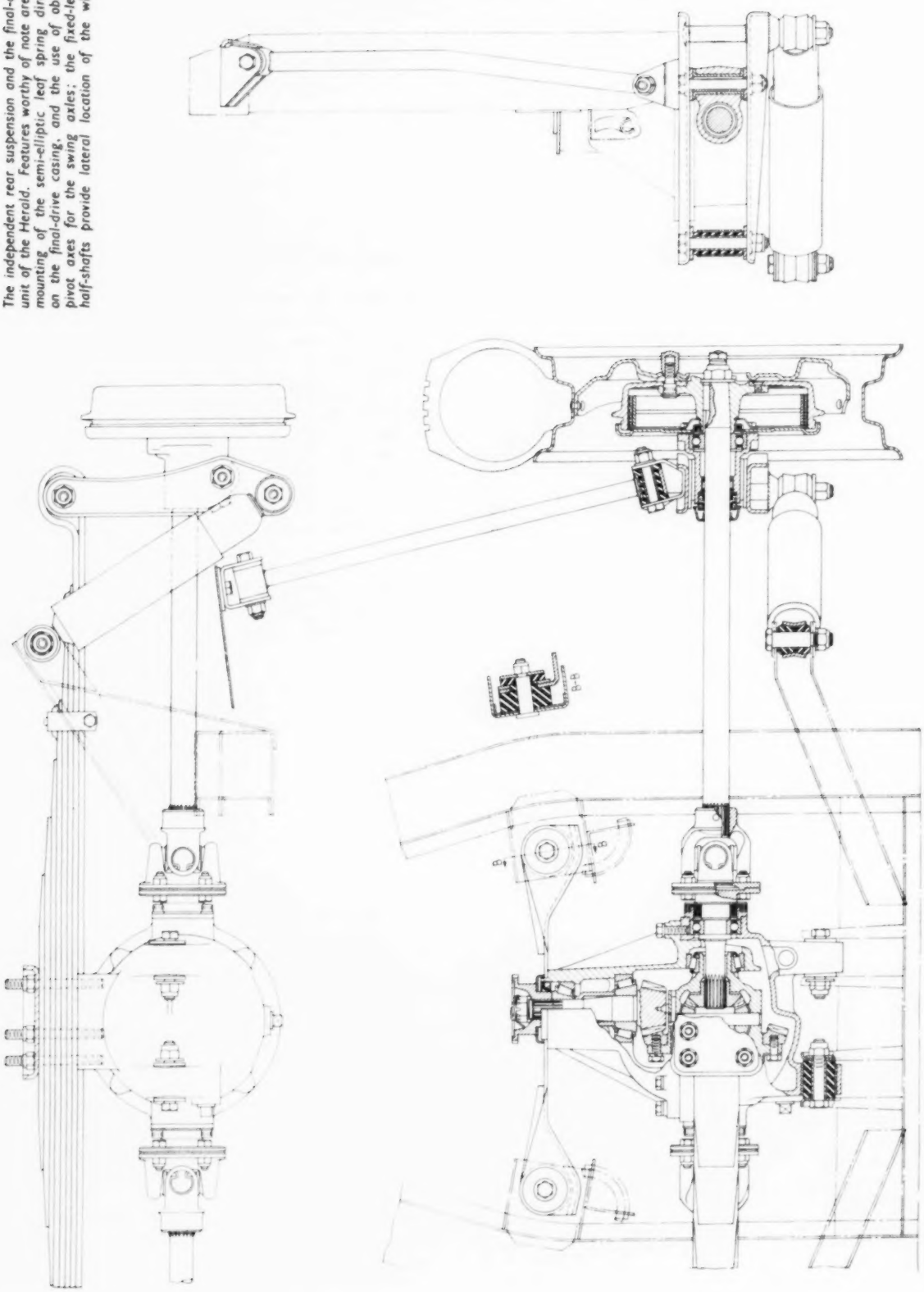
The Hardy Spicer propeller shaft is of the conventional, open type. Its length between the centres of the universal joints is 3 ft $11\frac{1}{2}$ in, and the tubular portion has a diameter and wall thickness of $2\frac{1}{4}$ in and 16 s.w.g. respectively. Because of the absence of angular movement of the propeller shaft, the running clearance between the shaft and the chassis frame is relatively small. The universal joints are of the latest design, embodying sealed needle roller bearings that require no routine maintenance throughout their life.

In its general layout, the hypoid bevel final-drive unit closely resembles that of the Standard Eight rear axle and,

The gearbox, of largely orthodox design, has been developed from the unit originally fitted to the Standard Eight car. Changes from the earlier version include a simplification of the lubrication system, and the replacement of the carbon thrust ring by a ball bearing in the clutch: only the upper of the alternative bearings illustrated is now used. On the latest cars, to increase rigidity, the gearbox shell is a separate iron casting



The independent rear suspension and the final-drive unit of the Herald. Features worthy of note are the mounting of the semi-elliptic leaf spring directly on the final-drive casing, and the use of oblique pivot axes for the swing axles; the fixed-length half-shafts provide lateral location of the wheels



in fact, that fitted as standard to the Herald saloon has the same 4·875 : 1 ratio. This ratio is obtained by the use of an 8-tooth pinion and a 39-tooth crown wheel. For the coupé and convertible, models, and the saloon if the two-carburettor engine is fitted, a ratio of 4·55 : 1 has been adopted : a 9-tooth pinion is used, in conjunction with a 41-tooth crown wheel, and, of course, the vertical offset of the pinion axis below that of the crown wheel remains unchanged at $\frac{1}{4}$ in. The two-pinion differential unit and its cage are identical with those previously employed. Both the cage and the pinion are carried in taper-roller bearings, the adjustment of the bearings and gear meshing being effected by shims, in the normal manner.

The casing of the final-drive unit naturally differs considerably from that of the live axle of the Standard Eight, which was of the banjo type. Externally, the malleable cast iron nose piece of the Herald casing is heavily webbed for stiffness, and it is attached to the main housing by eight $\frac{5}{16}$ in diameter bolts evenly spaced round the flange. On the leading end of the nose piece is machined the mounting spigot for the front bearer, which will be described at a later stage.

Cast iron is used for the main housing, on the back of which are two external lugs for the rear mountings. These mountings, too, will be described later. Machined on the top of the casing is a flat, recessed seating for the transverse leaf springs, and on each side of it is a projection of approximately square section. These projections are counterbored to receive the pressed-in outer races of the heavy-duty ball bearings in which the differential output shafts run. The nominal dimensions of the bearings are as follows : overall diameter, 2 in; bore, $\frac{7}{8}$ in; axial width, $\frac{9}{16}$ in.

Secured to the outboard face of each projection, by four $\frac{1}{4}$ in hexagon-socket screws, is the side cover, which is a malleable iron casting and contains a lip type oil seal. It has a male spigot that not only locates the seal coaxially with the bearing, and hence with the shaft, but also clamps the outer race against the shoulder in its housing. A shallow boss projects outward from each side cover, and is overlapped by a domed dust shield that is welded to the output shaft.

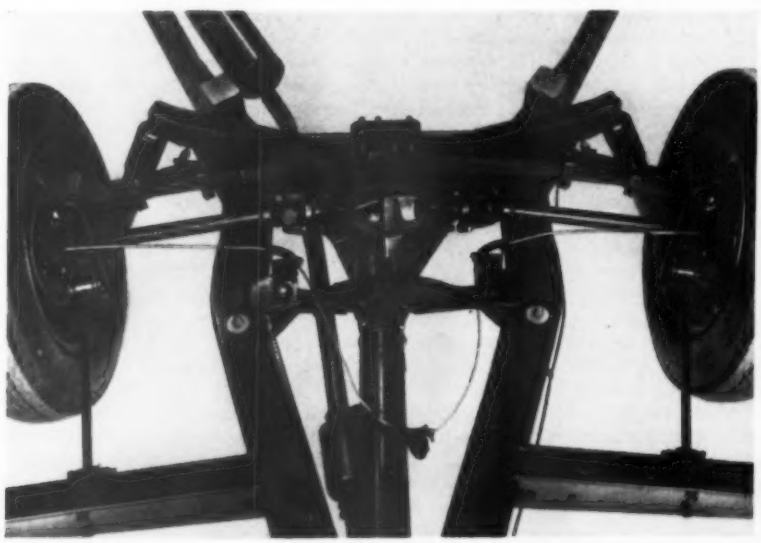
The output shafts are made of En.24 steel and are forged integrally with attachment flanges for the inboard yokes of the half-shaft universal joints, which are of the sealed type, similar to those of the propeller shaft. Each output shaft is shouldered to provide an abutment for the inner race of the supporting ball bearing. The race is retained by a plain washer and a circlip on the shaft.

For the half-shafts En.24 steel is employed, and they are nominally of $1\frac{1}{4}$ in diameter over most of their length. At their inboard ends are hobbed serrations for the outboard yokes of the universal joints. There are 24 serrations on each shaft; they are of involute form and their depth is 0·040 in. Since the half-shafts form the lower transverse arms of the swing-axle suspension system, the yokes are a press fit on the serrations, the nominal circular interference at the pitch line being 0·003 in. Axial location of each spider on its shaft is effected by a $\frac{1}{4}$ in diameter, grooved Mills pin, which is a driving fit in a diametral hole drilled through the boss of the yoke and the shaft; according to the manufacturers, the minimum pull-off load for the yoke, before the Mills pin is fitted, is 5 tons.

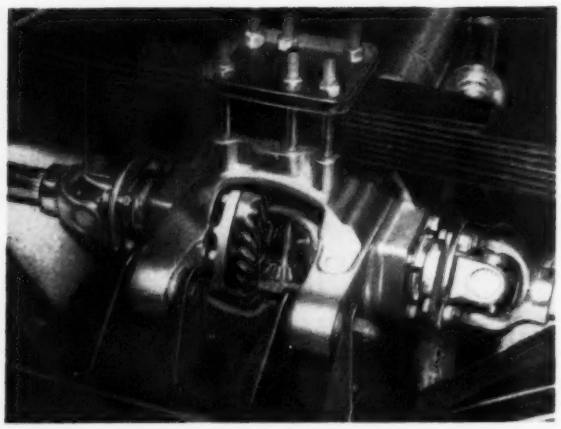
The forged, En.5Q wheel hubs are taper mounted on the outboard ends of the half-shafts, to which they are keyed. Inboard of the tapered portion, each shaft has a ground finish for a length of $3\frac{5}{16}$ in, to receive the two bearings and their seals. These bearings are housed in a malleable casting carrying the suspension shackle plates. The inboard bearing is a Torrington needle-roller unit containing 29 rollers measuring $\frac{1}{8} \times \frac{1}{2}$ in. Its outer race has no axial location in the housing member and, as is usual with this design of bearing, the rollers run directly on the locally hardened surface of the shaft.

Each outboard bearing is of the heavy-duty ball journal type. Its outside diameter is $2\frac{1}{4}$ in and its axial width is $\frac{3}{4}$ in. The outer race of the bearing is clamped against a counterbored shoulder in the housing by the brake back-plate, which is secured to the flanged outboard end of the housing by four $\frac{5}{16}$ in bolts. Axial location of the bearing housing relative to the hub member is effected by the contact between the inner race of the ball bearing and the inward extension of the hub boss; in fact, this extension is used to force the race into its final position. No cornering forces are taken by the outboard hub bearing, so heavy interference fits are not required. The only axial forces applied to the bearing arise from the angularity of the spring shackle plates and the damper, relative to the half-shaft axis.

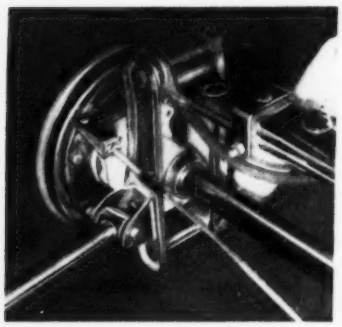
Because the replenishing interval for the bearing housing, which is filled with hub grease, is 12,000 miles, the sealing



The pivot bolts of the trailing radius rods are carried in brackets attached to the rear outriggers of the frame and to the spring shackles. Bolted to the front of the final-drive unit is a bearer of approximately elliptical shape; it is secured flexibly to brackets on the frame members



Above: This view of a part-sectioned final-drive unit illustrates the two-point rear mounting, between brackets on the rear cross member of the frame, and the method of clamping the spring to the casing



Close-up of the spring shackle and half-shaft bearing housing. The dust shield fitted on the shaft inboard of this housing is a recent modification

arrangements are unusually thorough. Fitted in a counterbore in the housing, immediately inboard of the needle-roller bearing, is a pressed steel sleeve containing two lip type seals mounted in tandem. A point of interest is that the seals are so arranged that over-lubrication results in the grease flowing through them rather than into the brake. Since the car was first introduced, a combined dust shield and flinger has been added to the assembly: it is pressed on to the shaft and overlaps the sleeve, which projects slightly from the bearing housing.

A third lip type seal is installed outboard of the ball bearing. It is pressed into a housing having an extended flange, which is sandwiched between the bearing housing and the brake back-plate. The seal bears on the boss of the hub member, the surface of which is locally ground. Completing the sealing layout is a pressed steel shroud, of part-conical form. The base flange of this shroud is clamped to the outer face of the back-plate by the four $\frac{5}{16}$ in diameter bolts already mentioned, and its crown is pierced for running clearance over the hub boss. Immediately inboard of the shroud, the boss has a shallow circumferential rib to act as a thrower in the event of grease seepage past the lip type seal. Any lubricant flung off is trapped by the shroud, from which it can escape through a hole drilled in the back-plate.

Mild steel sheet of 10 s.w.g. is employed for the fabricated front bearer member of the final-drive unit. This member, which is clearly shown in an accompanying illustration, is of roughly elliptical shape, with the major axis horizontal. An interesting feature of the design is the change of section from purely a web at the middle, to a channel—arrived at by giving a 90 deg bend to one edge of the main pressing, and welding on a flange near the other edge—and then to an inverted L section at the ends. Towards each end, the flanges of the channel portions converge to form a double thickness at the top of the inverted L section.

The bearer member is pierced in the middle of its web to enable it to fit over the spigot on the nose piece of the final-drive casing. It is attached by four $\frac{5}{16}$ in set-screws that enter holes drilled and tapped in bosses on the nose piece. At its outboard ends, the member is mounted below two brackets projecting inward from the frame longitudinals. The domed heads of the two $\frac{3}{8}$ in diameter attachment bolts are welded to the upper faces of the brackets, and their shouldered shanks project downward, through the flanges of the bearer.

To provide a degree of resilience in the mounting, thick rubber buffers are sandwiched between the bearer and the brackets. These buffers are of the spigoted type, and the spigots enter the holes in the bearer, thus preventing metal to metal contact. Below each flange of the bearer, a thinner, plain rubber buffer is fitted on the bolt, followed by a plain washer and a Nyloc nut. Tightening of the nut pulls the washer against the shoulder of the bolt, and so compresses the buffers by the desired amount.

The rear mounting of the final-drive unit is more orthodox. Welded to the upper and leading faces of the rear cross member of the frame are two pairs of brackets of arrow-head shape. They are 14 s.w.g. pressings having a shallow channel section; the flanges of each pair face mutually outwards. Between the brackets fit the two lugs on the rear of the final-drive casing. These lugs have $1\frac{1}{8}$ in bores to accept the outer sleeves of the Metalastik bonded rubber mounting bushes. The outer sleeve of each bush is shorter than the inner sleeve, thus ensuring that it does not foul the brackets when the inner sleeve is clamped between them. Bolts of $\frac{7}{16}$ in diameter pass through the bracket holes and the inner sleeves, and are fitted with plain washers and Nyloc nuts.

Rear suspension

One of the outstanding design features of the Herald is, of course, the independent rear suspension. Although the potential advantages of such suspension over a live axle are widely appreciated, a brief recapitulation will be of interest. In the first place, the lower unsprung weight results in a better ride, and ensures that the wheels are kept in more constant contact with the road. This improvement in wheel adhesion, which is aided by the absence of axle tramp, or wheel interaction over bumps, enhances the cornering and braking powers of the vehicle. The benefits are naturally more pronounced on rough roads than on smooth, but the Herald was designed with the export market very much in mind.

Additionally, the use of independent rear suspension should obviate the detrimental torsional effects that can and do occur with most live axle layouts. One of these is the "wind-up" of springs during acceleration or braking. The other is the tendency of propeller shaft torque reaction to rotate the axle about the shaft axis, thus giving differential vertical reactions at the wheel. Wind-up can cause judder or tramp on cornering, and can increase the likelihood of the wheels spinning on acceleration or locking during braking. The torque reaction of the propeller shaft, on the other hand, can result in loss of traction and in differences between the handling characteristics under power on left- and right-hand bends.

Since the final-drive unit is carried on the sprung portion of the vehicle, it is possible to eliminate the hump in the rear seat pan that is usually necessary to clear the nose piece of a live axle on full bump. Thus, the effective width

of comfortable seating is increased. Alternatively, the height of the seat pan may be reduced, to increase the head room or permit a lower roof line. Further advantages in this respect are that the boot space can be increased and the depth of the propeller shaft tunnel appreciably reduced. This last change saves material and facilitates interior layout.

After it had been decided that independent rear suspension should be employed on the Herald, the Triumph design team was faced with the problem of deciding which layout offers the best compromise between technical merit, robustness, and ease and economy of manufacture. Several possible arrangements were therefore investigated. The swing axle type made an immediate appeal on account of its simplicity and the relatively low cost resulting from the use of only one universal joint, without a sliding coupling, on each half-shaft.

It was duly decided to adopt such a layout, but a number of factors had to be considered in evolving a suitable geometry. The first of these were the two conflicting swing axle effects. One is that, in theory, body roll should result in the wheels leaning the opposite way to the body; in other words, they should lean into a corner, thus increasing their cornering power, with a consequent understeering tendency of the car.

However, the moment applied to the outside wheel by the cornering force, as the corner is entered, causes that wheel to adopt an outward lean. It follows that the rear of the car is lifted by the half-shaft on that side, and the cornering power is reduced from its theoretical value. The result of this reduction is an oversteering tendency, and the effect is magnified by the high roll centre inevitable with the basic swing axle layout. It follows that a positive camber of the wheels in the normal static load position is disadvantageous, because it results in a higher roll centre than does zero or negative camber.

A trailing or nearly trailing radius rod is, obviously, the lightest and simplest means of longitudinal location of a wheel mounted on a swing axle. With this design, however, the pivot axis for the wheel is oblique, not longitudinal, so suspension movement tends to affect wheel alignment: assuming that the radius rod is horizontal in the static load position, and that its rear end pivots about the half-shaft axis, movement of the wheel up or down from its normal position produces a slight degree of toe-in. If the wheels are vertical at the static load position, body roll clearly causes an equal toe-in of both wheels, so there is no net steering effect.

On the other hand, if the wheels initially have a negative camber—to lower the roll centre and minimize the jacking-up effect of the swing axle layout—the toe-in of the outer wheel exceeds that of the other, so roll understeer of the car occurs. Conversely, a positive camber of the wheels tends to cause roll oversteer, which is added to that resulting from the increased jacking-up action. By varying the positions of the pivots of the radius rods in relation to the half-shafts, however, it is possible to modify these basic effects to an appreciable extent, and hence to obtain the desired rear end characteristics.

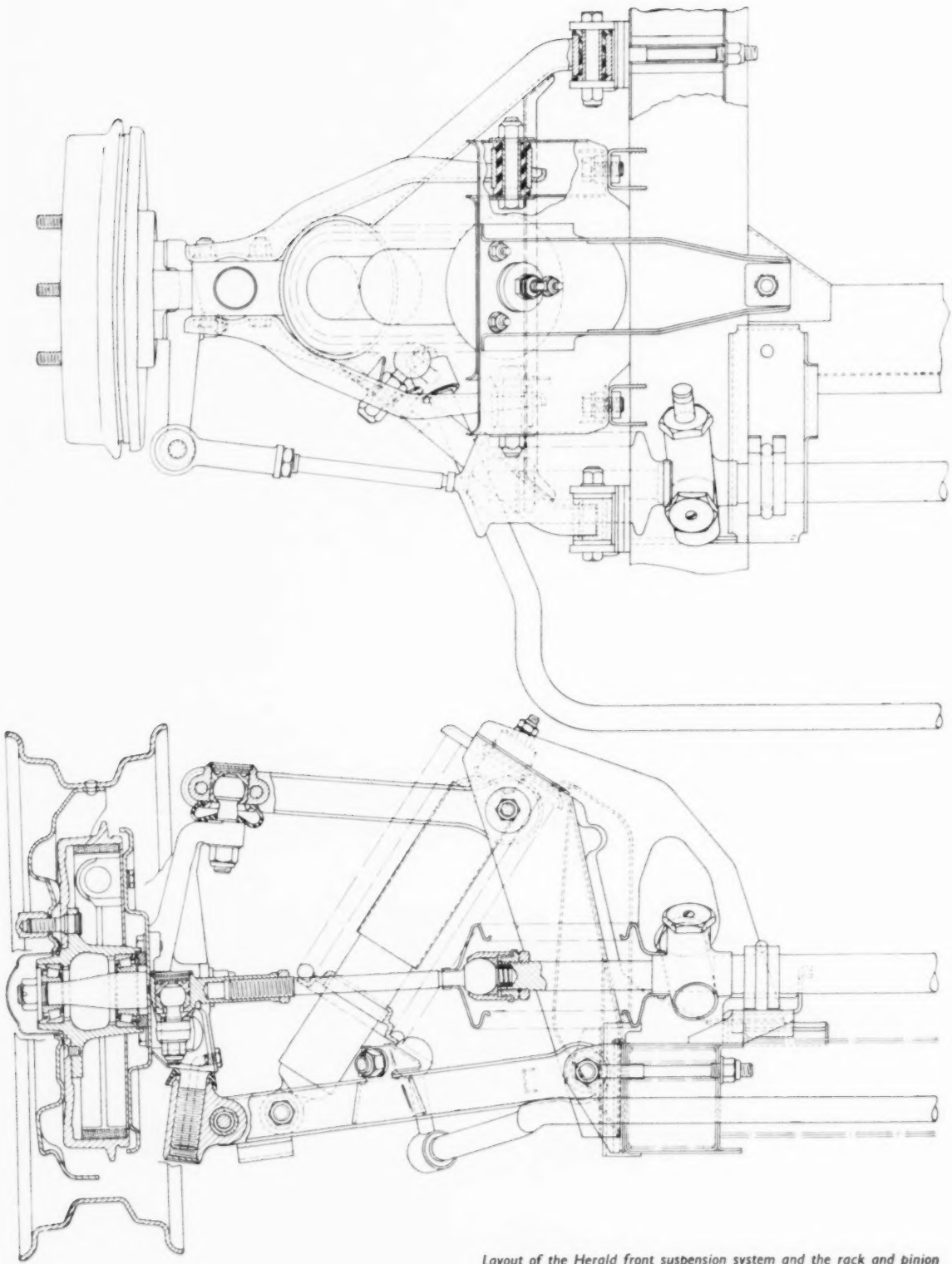
Whatever geometry is chosen for a swing axle layout, consistency of handling under various conditions of load and rates of cornering necessitates a limited range of roll. This, in turn, means that the roll stiffness must be relatively high. In addition, the rear end effects must, of course, be related to the roll steer characteristics of the front suspension and to the weight distribution of the car.

In achieving what they regard as the best compromise in these various respects, the Triumph engineers have evolved a layout of considerable interest. The wheels have a small degree of negative camber in the static load position and are located longitudinally by slightly splayed radius rods. To impart a slight amount of roll understeer, the rods are disposed below the horizontal plane through the axes of the half-shafts, and trail slightly upward. A transverse, semi-elliptic leaf spring is employed rather than coil springs, because it offers several advantages in this application. Its method of anchorage, directly to the top of the final-drive casing, and by shackles to the half-shaft bearing housings, is simpler than would be that of coil springs. Again, it can react part of the braking torque and of the longitudinal road-forces, thus permitting the radius rods to be of relatively light construction.

The spring has a length of 41 in between the centres of the eyes, measured under normal static load conditions, in which it has a slight negative camber. There are eleven leaves on the spring fitted to the saloon and convertible models, and eight on that of the coupé; all the leaves have a section of $1{\cdot}75 \times \frac{3}{8}$ in and are made from En.45A steel. The spring is inverted, in comparison with those of a normal live axle system, and the ends of the master leaf are



Turret brackets, bolted to the two frame longitudinals, carry the upper wishbones and upper abutments of the springs. Cars now in production have stiffer springs than those shown and another modification is the bridging of the arms of each of the lower wishbones by a light channel member



Layout of the Herald front suspension system and the rack and pinion steering mechanism. Unlubricated ball-joint seatings of nylon are used at the top of each swivel member and in the steering linkage. Nylon is also used for the pivot bush of the trunnion at the bottom of the swivel member. The trunnion bearing has its own oil reservoir

rolled towards the other leaves to form the eyes. As a safety measure, the second leaf is curled round the eyes, with adequate clearance to accommodate any relative movement. On the lighter of the two types of spring, the outer ends of the remaining shorter leaves have a truncated taper in width and on their upper surfaces; the leaves of the other spring have square ends and a constant thickness.

Into the underside of the third, fourth and fifth leaves, near each end, are pressed circular indentations, in which are fitted synthetic rubber buttons to reduce inter-leaf friction. There are similar buttons between the master and second leaves, immediately inboard of the eye. The buttons have a diameter of 0·75 in and a thickness of 0·25 in.

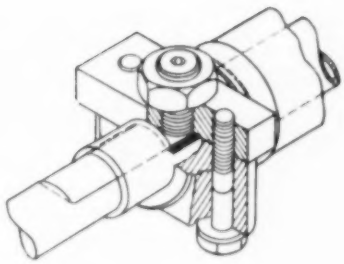
A $\frac{3}{8}$ in diameter bolt clamps the leaves together at the middle. In the centre of the seating face on the final-drive casing is a blind hole that accommodates the head of the bolt. The anchor plate is a pressing made of En.2A/1 steel. It is of rectangular form, with radiused corners, and has a raised peripheral flange 0·63 in deep, to resist bending. In the middle of the plate is a $\frac{1}{4}$ in medial hole, to clear the nut of the spring clamping bolt. The plate is pulled down by six $\frac{1}{8}$ in diameter studs screwed into the casing. Four of the studs are sited near the corners of the plate, but the other two—disposed one on each side of the spring—are staggered in relation to the longitudinal centre line of the vehicle. This staggering is to provide a greater vertical thickness of wall into which the studs are screwed.

In the spring eyes are bonded rubber bearings of Metalastik or Silentbloc manufacture, having inside and outside diameters of $\frac{7}{16}$ in and 1 in respectively. The inner sleeves of the bearings are longer than the outer sleeves, to provide clearance between the spring eyes and the shackle plates. Each shackle consists of two side plates, which are pressed from 10 s.w.g. En.2 material, and are of channel section which widens locally a little below their centres. This swelling is to accommodate the pivot bolt that passes through a boss on the half-shaft bearing housing. In the case of the leading plate, it also accommodates the channel bracket carrying the pivot of the trailing end of the radius rod.

A $\frac{7}{16}$ in diameter bolt passes through the inner sleeve of each spring eye bearing and through holes in the shackle plates, the adjacent faces of which are locally reinforced by welded-on washers. Completing the assembly are a plain washer and a Nyloc nut. The pivot bolt mentioned in the previous paragraph also has a diameter of $\frac{7}{16}$ in. On it is mounted a steel sleeve which passes through a two-piece flanged bush, one portion of which is fitted from the front and the other from the rear, into the bore of the boss on the bearing housing. Rubber rings are fitted over the flanges of the bushes, and abut against the shackle plates, to exclude foreign matter. Again, a plain washer and a Nyloc nut are fitted to the bolt.

The telescopic dampers, which may be of Armstrong, Girling or Woodhead-Monroe manufacture, have a bore of 1 in, and are inclined inward at about 32 deg to the vertical in the static laden condition. At its lower end, each is carried on a steel pin of $\frac{3}{8}$ in outside diameter. This tube passes through both shackle plates and is welded to them. The conical rubber half-bushes in the damper eye fit over the pin, and are pre-loaded and retained by a plain washer and Nyloc nut. The upper anchorages of the dampers, on the inclined brackets described in Part I of this article, embody bushes of the type just described.

Steel tubing of $\frac{1}{4}$ in outside diameter and 10 s.w.g. is employed for the radius rods. To the ends of each tube are welded short transverse tubes, also of 10 s.w.g. material, which house the Metalastik or Silentbloc pivot bearings. In these bearings, the rubber bushes are bonded to the inner sleeve only, the outer sleeve being formed by the housing tube. The carrier bracket for the rear end of each radius rod is welded to the leading face of the appropriate shackle, but that for the front end of the rod is secured by two $\frac{5}{16}$ in bolts to the rearmost outrigger of the frame. Viewed in plan, the radius rods are splayed outward from their front mountings at an angle of 15 deg to the longitudinal. Their slight upward trail, when the wheels are in the normal static load position, has already been mentioned.



An ingenious feature is the Impactoscopic steering column. In a frontal collision, this telescopes, owing to the driver's inertia, thereby reducing the risk of serious injury

Since the radius rods are only splayed by a small angle, they exert good longitudinal control. The geometry of the suspension is such that the negative camber of the wheels, with the vehicle normally laden, is approximately 2 deg on the saloon and convertible models, but is zero on the coupé version. Other characteristics of the suspension are as follows: effective length of half-shaft, 17·69 in; effective length of radius rod, 16·03 in; camber angle at full bump, −8 deg; camber angle at full rebound, +10 deg; maximum track variation, 7 in; spring rate, measured at wheel, 76 lb/in for the saloon and convertible, and 57 lb/in for the coupé; periodicities, 66 and 67·5 c/min; roll centre heights, 13·8 and 14·75 in; roll stiffnesses, 128 and 96 lb-ft/deg; total wheel travel, 5·5 in.

Front suspension

For the front suspension, which is manufactured by Alford and Alder Ltd, a basically conventional layout has been adopted. It comprises double transverse wishbones of unequal length, coil springs with coaxial dampers, and an anti-roll bar. However, the springs have a relatively small coil diameter and are inclined at a considerable angle to the vertical. The inclined mounting of the springs was adopted to minimize the bending moments in the lower wishbones, and the reactions at the inboard pivot bearings, due to vertical loads at the wheels. Following established Triumph practice, each upper wishbone is connected by a ball-joint to the appropriate steering swivel member, and the lower end of the swivel is carried in a trunnion bearing on the lower wishbone. Periodic lubrication of the suspension has been made unnecessary by the use of rubber pivot bearings, and of nylon in other joints.

On earlier production models of the Herald, the springs were of relatively low rate, with closely pitched coils, and the necessary roll stiffness was provided by an anti-roll bar of larger than average diameter. Current cars, however, have springs of a wider coil pitch, and therefore higher rate, and the diameter of the anti-roll bar has been reduced accordingly. The roll stiffness has not been significantly changed by the modifications and, although the ride is inevitably rather more firm, the company considers the present compromise to be the more satisfactory of the two.

Each upper wishbone comprises two identical channel-section pressings, of 12 s.w.g. En.2A/1 steel, disposed with the flanges facing mutually outwards. The arms of the wishbone are curved, as viewed in plan, to provide working clearance over the spring, the upper portion of which passes between them. A hole at the inner end of each arm houses the welded-on outer sleeve for the pivot bearing, the rubber

bush of which is bonded to the inner sleeve only. This sleeve is clamped between flanges on the large turret bracket bolted to the frame longitudinal. The pivot bolts are $\frac{3}{8}$ in diameter and are secured by stiff-nuts.

Clamped between the outboard ends of each upper wishbone, by means of two $\frac{5}{16}$ in diameter bolts, is the ball-joint housing—an En.8D steel stamping. The ball-joint itself comprises a ball-pin—made of a carbon steel and induction hardened—and a split nylon seating. For axial location of the lower portion of the seating, the bottom of the bore in the housing is provided with a 45 deg shoulder, the seating having a corresponding chamfer at the bottom.

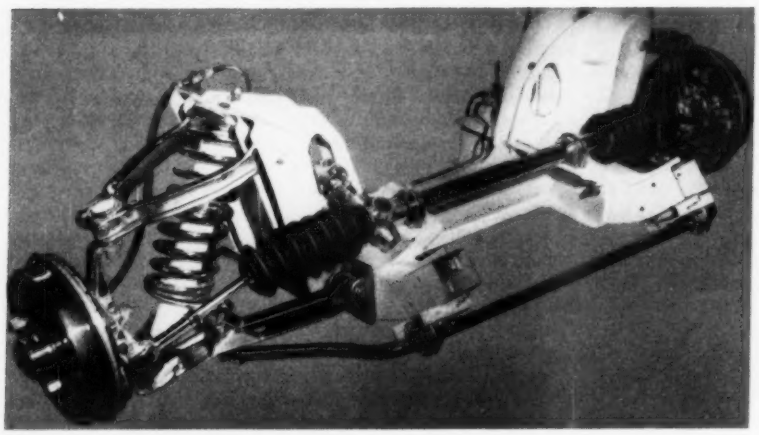
On assembly of the joint, the lower half-seating is pressed into the bore, after which the ball-pin is inserted from above. Next, the upper half-seating is pushed in until it contacts the ball. A plate spring is then fitted, followed by the retaining cap: this cap is a steel disc fitted in a shallow counterbore at the top of the bore and secured by peening of the surrounding lip. The tapered shank of the ball-pin is carried in a lug at the upper end of the steering swivel. Between the shank and the housing is a synthetic rubber sealing gaiter.

To enable the lower wishbones to resist longitudinal loads and brake torque, the pivot bearings of each are much more widely spaced than those of the upper wishbones. Again, the arms are 12 s.w.g. En.2A/1 steel pressings of channel section, and the anchor bracket for the anti-roll bar is welded to the leading one. Originally, the arms were separate components, but the strength of the wishbone assembly has been increased by the incorporation of a welded-on, channel-section member that bridges them near their inboard ends.

The pivot bearings at the inboard ends of the arms are now of the same type as those of the upper wishbones. On earlier cars these bearings incorporated flanged half-bushes of nylon, but a change to rubber was made after a few months of production, in the interest of quiet operation. The inner sleeve of each bearing is clamped between the ears of a bracket bolted to the frame longitudinal.

Bridging the outboard ends of the arms of each lower wishbone are the inner sleeves of two additional pivot bearings. The more inboard of these bearings is that for the lower end of the suspension spring and damper assembly; it is of similar type to those fitted to the inboard pivots of the wishbones. Outboard of it is the bearing that carries the trunnion housing at the lower end of the steering swivel member. This second bearing is of the split-bush, nylon type described in the previous paragraph. In this application, nylon is preferred to rubber because of its greater rigidity. Stiff-nuts of the Nyloc type are used on all the pivot bolts of the front suspension.

Adjustments to camber and castor angles are readily effected by varying the number of shims fitted between the lower wishbone pivot brackets and the frame longitudinals. To decrease the camber angle, shims of equal number are added behind both brackets, whereas an increase of angle necessitates the removal of shims, again of equal number. If the castor angle is to be increased, shims are removed from behind the leading bracket or fitted behind the trailing bracket. Since an alteration to the castor angle also affects the camber, both angles must be checked after this operation, and a further adjustment made if necessary.





Left: U-bolts clamp the rack tube of the steering assembly to brackets on the frame, and the column passes through the turret bracket. When the stiffer front springs were adopted, the diameter of the anti-roll bar was reduced, to maintain the existing roll stiffness. Right: Close-up of the steering swivel and front brake assembly; 8 in diameter drums are fitted to the front wheels, whereas the rear wheels have 7 in diameter drums

Manganese-bronze is employed for the trunnion units, which embody threaded swivel bearings; the thread has 10 t.p.i. and its outside diameter is $\frac{3}{4}$ in. The female thread is formed directly in the trunnion, and the male thread is machined on a downward projecting spindle integral with the swivel member. Ample surface area to resist wear is afforded by the thread engagement length of $1\frac{1}{4}$ in.

The spindle just mentioned has a $\frac{1}{4}$ in diameter axial hole which, together with the space at the bottom of the bore in the trunnion, forms an oil reservoir for the lubrication of the threads. At the top of the hole is a radial drilling, for filling purposes; it is normally closed by a screw-in plug. To retain the oil and to exclude dirt and water, a synthetic rubber shroud, of umbrella type, is fitted round the shank of the spindle.

An interesting feature of the steering swivel members, which are En.8Q steel forgings, is the use of sturdy gusset webs between the upward projections, which carry the ball-pins, and the mounting bosses for the wheel stub axles. The stub axles themselves are manufactured also from En.8Q steel; each is taper mounted in its swivel member and is secured by a $\frac{1}{2}$ in U.N.F. stiff-nut.

For the coil springs, En.45A wire of 0·45 in diameter is used. The outside diameter of the coil is 3·58 in and each spring has $9\frac{1}{2}$ effective turns. A free length of 11·7 in and an installed length of 7·8 in, normally loaded, are quoted by the manufacturers. The spring rate is 203 lb/in, which is equivalent to 85 lb/in at the wheel; a total wheel travel

of 6½ in is available. At its lower end, each spring seats in an annulus welded, or retained by split rings, to the body of the telescopic damper, near its lower end. A cupped pressing, bolted to the turret bracket on the frame, forms the upper abutment of the spring. The dampers, which again are of Armstrong, Girling or Woodhead-Monroe manufacture, have a 1 in bore and embody both the bump and the rebound stops. As has already been indicated, their bottom mountings are of the rubber bush type, whereas sandwich type mountings are employed at the top.

The anti-roll bar is made from En.42 or 44 steel, and its diameter is $\frac{1}{16}$ in. It is carried in rubber bushes clamped to the underside of the upswept, frontal extensions of the frame longitudinals. The outer portions of the bar are semi-trailing, and the rubber bushed ends are connected to the lower wishbones by short vertical links; at the top of each link is a ball-joint, the pin of which is bolted to the bracket on the wishbone front arm. A slight inward crank is given to each semi-trailing portion of the bar, to bring it clear of the tyre on full lock.

This suspension system has the following principal dimensions: castor angle, +4 deg; camber angle, normally laden, +2 deg; camber angle at full bump, −3 deg; camber angle at full rebound, +5¼ deg; swivel inclination, normally laden, 6¼ deg; offset of swivel axis from centre of tyre contact area, 1·3 in; total track change from static load position to full bump, 1·5 in; effective length of suspension upper wishbones, 7·75 in; effective length of suspension lower wishbones, 10·13 in; roll stiffness, 213 lb-ft/deg; roll centre height, 6·5 in; periodicity, 78 c/min.

Steering

The rack-and-pinion steering gear, also made by Alford and Alder, is of orthodox design. To permit a simple and direct layout, with the attendant advantage of a well raked column, the rack unit is mounted ahead of the engine, immediately behind the radiator; it is clamped by U-bolts to brackets welded to the frame longitudinals. The pinion housing is situated well inboard, in order to provide an exceptional lock, while maintaining satisfactory steering geometry. It is, in fact, only about 8 in from the longitudinal axis of the car. As a result, the steering column is inclined outward as well as upward, to bring the wheel into the required position. Owing to the length of the column, however, the lateral inclination is only about 4½ deg.

In order to accommodate the lateral offset, the teeth of the pinion have the appropriate helical angle, while those of the rack are perpendicular to its axis. Where left-hand steering is fitted, the pinion helix angle is of the opposite hand, as also is the pinion housing. En.8D steel is employed for the rack, and En.352A for the pinion, which has 7 teeth of involute form and with a d.p. of 12. The rack has 29 teeth, to cater for the 3¼ turns of the steering wheel from lock to lock; limit stops are embodied between the rack and its tubular casing. Since the turning circle is only 25 ft —remarkably small for a car of 7 ft 7½ in wheelbase and 4 ft track—the steering is not as low geared as would at first appear.

The pinion housing is an aluminium casting, and the rack tube is constructed of 14 s.w.g. mild steel, butt welded and drawn. Supporting the pinion shaft are two sintered copper-iron bushes of the oil impregnated type. To avoid backlash, and the excessive transmission of road reactions back to the steering wheel, the rack is pressed downward on to the pinion by a spring loaded plunger, the friction loading of which is adjustable by means of shims. At the end of the tube remote from the pinion, the rack slides in a Clevite bush.

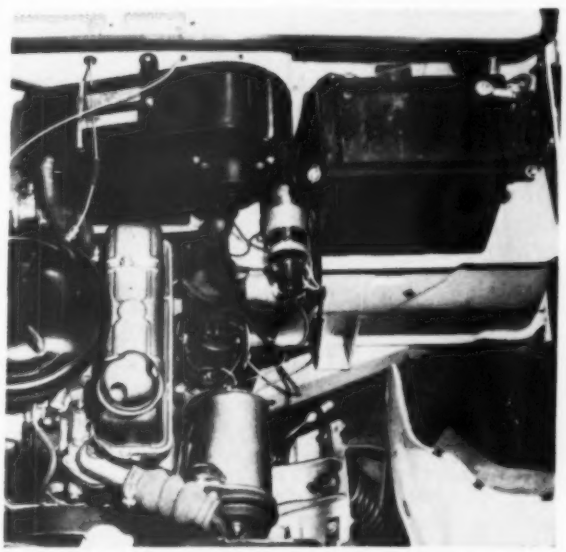
Screwed on to each end of the rack is the steel housing for the ball-joint attaching the rack to the steering link. The outboard portion of the ball socket is machined in the housing, but the inboard portion is a steel cup. A shallow axial hole, drilled in the end of the rack member, houses the spring that keeps the cup in contact with the ball. The housing is secured to the rack by a lock nut. Sealing of the complete rack and pinion unit, which is lubricated by grease, is effected by means of two convoluted gaiters of synthetic rubber. Each gaiter is clipped at one end to the rack tube and at the other to the link.

The ball of this joint is forged integrally with the En.8D link and is hardened. Tracking of the wheels is accomplished in the usual way, by screwing the links into or out of their outboard end-pieces. The steering levers, stampings of En.16T steel, are each secured by two bolts to the appropriate steering swivel member. They project forward of the axes of the wheels, and each carries a taper mounted ball-pin at its leading end. This ball-pin seats in a nylon socket in the end-piece of the steering link; the socket is of similar design to that on the upper wishbone. The layout of the steering levers, links and rack is such that the geometry approximates to Ackerman up to moderate steering angles; it then passes through parallel to reverse Ackerman geometry at full lock. Tyre wear is not significantly affected by this arrangement, since the extremes of lock can be used only at low speeds. The maximum back and front locks are respectively 48 and 50½ deg.

An ingenious and praiseworthy safety device is embodied in the steering column. This device, which has been patented, is well described by its name—Impactoscopic—since it enables the column to telescope under heavy frontal impact, thus greatly reducing the risk of the driver's sustaining a chest injury from the steering wheel, in the event of an accident. The lower portion of the column is a solid steel bar, of circular section. A flat is formed on the upper 7 in of its length and this portion is enclosed in a steel tube; the bar is a sliding fit in the tube, which forms the upper portion of the column and rotates in steel-backed nylon bearings mounted in rubber inside a stationary tube clamped to the dash.

Below the lower end of the stationary tube, the rotatable tube is slotted transversely to expose the flat on the bar.

Much of the Herald's electrical equipment can be seen here. The heater assembly, a standard fitment, does not impair accessibility; its fresh air intake grille is just in view on the top of the scuttle



In the original design, a curved spring plate fitted into the slot and was bolted to a half-clamp embracing the whole of the unslotted circumference of the tube. Since the flat on the bar stood slightly proud of the half-clamp, the bar and the tube rotated as one. Relative axial movement between the two components was resisted only by the friction between the plate and the flat. In the latest layout, the same principle is employed, but the spring plate is replaced by a rigid one, in the middle of which is a hexagon-socket grub screw, with a lock nut. The screw is tightened on to the shaft with a specific torque, an arrangement that gives a closer control over the friction grip than did the earlier method.

Sufficient grip is applied by the grub screw to ensure that there can be no axial movement between shaft and tube in normal driving, or even under deceleration forces of up to 2g. On more rapid deceleration, however, the inertia of the driver is sufficient to overcome the clamping friction, and the column will telescope. The total range of travel permitted by this arrangement is approximately 6½ in, of which up to 4 in from the fully extended position is available for adjustment to suit the steering wheel position to the driver's stature and preference. It is not recommended that any more of the travel be used in this way, or the amount left for an emergency would be insufficient to afford worthwhile protection.

Wheels and brakes

Pressed steel disc wheels of conventional design and having a four-stud mounting, are fitted to the Herald. The rims have a diameter of 13 in and a section width of 3·5 in. Dunlop 5·20-13 in tubeless tyres are the standard equipment. For normal running, with two occupants, the recommended pressures for all three models are: front, 19 lb/in²; rear, 24 lb/in². If a full load is carried in the saloon or convertible, the rear tyre pressure should be raised by 4 lb/in².

Little comment is called for regarding the Girling hydraulic braking system of the Herald, since it follows normal practice. At the front, a two-leading-shoe layout is employed, and the drum diameter is 8 in; the rear brakes have 7 in diameter drums and a leading and trailing shoe disposition. In each case, the lining width is 1¼ in. The master cylinder is mounted on the front face of the dash, alongside the similar cylinder for the clutch, and is actuated directly by a pendant pedal. Lining and swept areas, respectively 72 and 117·8 in², should be adequate for the weight and performance of the vehicle.

The handbrake lever, which is relatively short, is mounted almost horizontally on the transmission tunnel, between the front seats. It is thus equally convenient for cars having right-hand or left-hand drive. The lever is connected by a longitudinal cable, enclosed by the tunnel, to the end of a transverse relay lever mounted a short distance ahead of the final-drive unit. Pivoting on this lever, about midway along its length, is a compensating bracket. Viewed in plan, this bracket has the approximate shape of a Y, the arcuate arms of which form a guide for the mid-portion of the single cable that actuates both brakes; the pivot is on the leg of the Y.

To the rear of the compensating bracket, the two runs of the cable diverge, at an angle of about 30 deg, as far as the front mounting of the final-drive unit. Here, each run passes through an arc-shape, tubular conduit, beyond which its direction is transverse. At each end of the cable is a clevis for attachment to the operating lever on the brake back-plate. To allow compensation for stretch, this cable is adjustable at its right-hand end. Adjustment is also provided at the leading end of the short cable between the hand lever and the compensating bracket, thus facilitating the correct setting of the relay lever.

The four-bolt attachment of the rear brake back-plates to the hub assemblies was mentioned earlier, in the section on the final drive. Four bolts also attach each front back-plate to the flange of the steering swivel member. Two of these bolts serve the secondary purpose of attaching the steering lever to the swivel.

Electrical equipment

As would be expected, the bulk of the standard electrical equipment is of Lucas manufacture; the exceptions are the sparking plugs, heater and horns. The M35G starter motor occupies the conventional position on the left-hand side of the crankcase. Its pinion has 9 teeth, and there are 117 teeth on the flywheel ring. The C40-1 generator has a maximum output of 22 amps at 2,050 to 2,250 r.p.m; it is driven at 1·355 times engine speed by the single V-belt that also drives the water pump and fan. Controlling the generator output is a normal current-voltage regulator, having the type designation RB.106/2.

The DM2P4 distributor, which has a relatively high and slightly inclined mounting on the left of the engine, has centrifugal and vacuum automatic control of the advance and retard mechanism. As was mentioned in Part I of this article, the advance characteristics differ between the single-carburettor and two-carburettor versions of the engine. Since the coil is mounted on the dash, just to the left of the engine, its lead to the distributor is short. The sparking plugs are Lodge type HLN.

Alongside the coil is the BT7A battery, which has capacities at the 10-hour and 20-hour discharge rates of 38 and 43 amp-hr respectively. F700 Mark VI headlamps are standard equipment and, for use in this country, are fitted

SPECIFICATION

TRANSMISSION : Single-dry-plate clutch, 6½ in diameter, with hydraulic actuation. Four-speed gearbox having synchromesh on top, third and second gears. Remote floor type manual control. Ratios : top, 1 : 1 ; third, 1·454 : 1 ; second, 2·46 : 1 ; first and reverse, 4·271 : 1. Dry weight, 51·3 lb, complete with clutch slave cylinder and throw-out assembly, gear change mechanism, and rear extension and mountings. Fixed length open propellor shaft with sealed needle roller bearing universal joints. Hypoid bevel final-drive unit carried on chassis frame, driving wheels through fixed length half-shafts having sealed needle roller bearing universal joints at inboard ends only. Ratios : 4·875 : 1 with single-carburettor engine ; 4·55 : 1 with two-carburettor engine. Speeds per 1,000 r.p.m. in top gear, 13·3 and 14·2 m.p.h. respectively. Dry weight, less universal joint spiders and front bearer, 49·5 lb.

SUSPENSION : Front, double transverse wishbone links, having coil springs mounted coaxially with telescopic dampers. Rear, independent, swing axle type, with transverse semi-elliptic spring and trailing radius rods ; telescopic dampers. Weight of complete rear axle and suspension assembly, including wheels and tyres, 180·5 lb.

STEERING : Rack and pinion. 3¾ turns of steering wheel from lock to lock. Turning circle, 25 ft.

BRAKES : Hydraulic. Front brakes have 8 in diameter drums and two leading shoes ; rear brakes have 7 in diameter drums and leading and trailing shoe layout. Lining width, front and rear, 1¼ in ; total swept area, 117·8 in². Mechanically actuated hand brake.

WHEELS : Steel disc type with four-stud attachment and 3·5 in wide rims. Tubeless tyres, 5·20—13 in.

DIMENSIONS : Wheelbase, 7 ft 7½ in. Track, front and rear, 4 ft. Overall length, 12 ft 9 in. Overall width, 5 ft. Overall heights : saloon, 4 ft 4 in ; coupé, 4 ft 3½ in ; convertible, 4 ft 4 in (4 ft 0½ in with head lowered). Ground clearance, 6¾ in. Frontal areas : saloon, 16·13 ft² ; coupé, 16·02 ft² ; convertible, 16·1 ft². Kerb weights with 7 gal fuel : saloon, 1,778 lb ; coupé, 1,715 lb ; convertible, 1,743 lb. Weight distributions : saloon, 52·0/48·0 per cent ; coupé, 53·9/46·1 per cent ; convertible, 53·3/46·7 per cent.

Right: Below the headlamps, which have bezels of an unusual shape, are the turn indicator and sidelamp groups. Far right: The rear lamp and turn indicator units form continuations of the bumper over-riders





with 50/40 watt bulbs, with left-hand dipping. Appropriate alternative bulbs, with right-hand or vertical dipping, are supplied on cars for export. Flashing type turn indicators are embodied in the side and rear lamp groups, in the now conventional manner.

Continental practice is followed in respect of the lighting controls. On the facia is the three-position master switch. When this is in either of its two "on" positions, current is fed to a selector lever, conveniently mounted below the steering wheel, on the left-hand side of the column; in the second of these positions, the instrument lighting is also brought into circuit. The selector lever, too, has three positions, giving side lamps or headlamp main or dipped beams. A similar lever on the right of the column controls the turn indicators.

A 3½ kW heater is standard equipment on all three models; it is of the fresh-air type, drawing in air through a grille in the bonnet top. Either a Smiths or a Delaney Gallay unit may be fitted, according to availability, the two being interchangeable. Another standard item in the specification, unusual in a car of this class, is windscreen washing equipment, of Sydney or Tudor manufacture. The two Clear Hooter type 725 wind-tone horns are mounted ahead of the radiator, one being sited on each side.

Machine Tool Research

A NEW Research Association is now in process of formation specifically to serve the British machine tool industry. It is sponsored by the Machine Tool Trades Association, who took a leading part in the establishment of the Production Engineering Research Association nearly twenty years ago. The new Research Association will administer funds contributed by the industry for the purpose of co-ordinating, accelerating and initiating research projects for the benefit of machine tool design and production. To this end, all appropriate and available existing research facilities throughout the country will be used.

Thus, results from a wide range of research projects will become more quickly available to the industry than would be possible if the Machine Tool Industry Research Association were to wait for the erection and equipment of their own laboratories. An early and useful effect will be the acceleration of work on machine tool projects at present proceeding at Research Associations, Universities, Government establishments and privately owned laboratories.

New work will be contracted out to such establishments, under the supervision of a Director of Research, of the highest qualifications, who will be appointed at an early date. Approximately 100 manufacturers of machine tools, and those in closely allied industries, have undertaken the financing of the new Research Association for a minimum of five years. It is the intention to apply for assistance to the Industrial Grants Committee, which is organized by the Department of Scientific and Industrial Research.

Chromium Plating

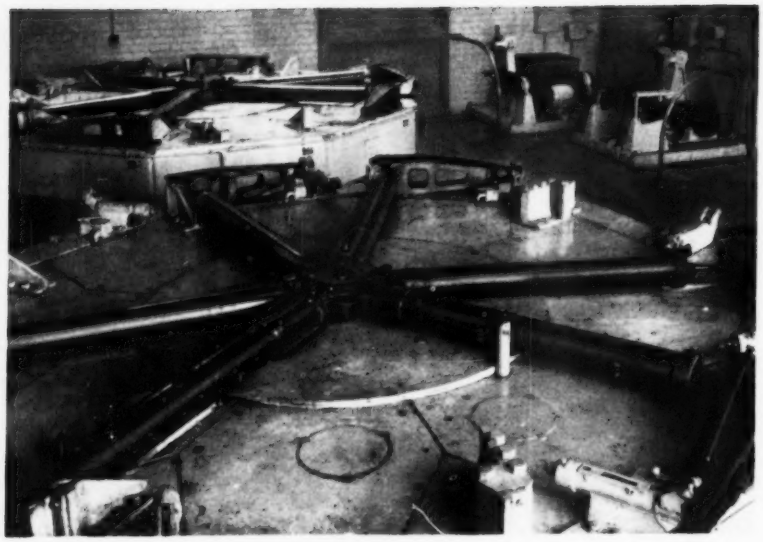
IN THE March issue of *Automobile Engineer*, reference was made to improvements in the techniques used in the U.S.A. for chromium plating. Since that issue went to press, information has been received regarding the plating on all cars and commercial vehicles now being manufactured by the Chrysler Corporation. In comparison with the plating on earlier vehicles, the latest finish is said to provide double the resistance to corrosion and to be less susceptible to accidental damage. These advantages are obtained by the use of a heavier nickel coating, which is in two layers: one, comprising 75 per cent of the total, is bright and the other is semi-bright.

This technique is employed to obtain the advantages of both forms of nickel. The grain of semi-bright nickel is disposed perpendicular to the surface of the article, whereas that of bright nickel is parallel to the surface. Also, the semi-bright form is considerably more ductile than the other. The perpendicular grain structure gives the greater corrosion resistance, and the ductility ensures that this resistance is not adversely affected by moderate bending. On the other hand, the amount of bright nickel is sufficient to make buffing unnecessary before the application of the chromium layer. In the case of components of zinc-base alloy, an undercoating of copper is deposited before the nickel, but that coating is not required on steel items such as bumpers.

There is no doubt that a real effort is being made in the U.S.A. to improve chromium plating. In view of the large amount of this decorative finish that is still used on American vehicles, this is obviously a desirable development. Since the newer processes can reasonably be expected to cost more than their predecessors, it will be interesting to see whether the alternative materials, stainless steel and aluminium continue their penetration of the market.

Rover with Powered Steering

POWER-ASSISTED steering is to be available as an optional extra on the 1961 version of the Rover 3 Litre car. The unit adopted is the Hydrosteer integral type described in detail in the May 1960 issue of *Automobile Engineer*. Examples of the 3 Litre car fitted with this equipment were first exhibited at the recent Paris Motor Show, and they will, of course, be appearing at the London Show later this month. A Hobourn-Eaton roller type hydraulic pump, driven from the crankshaft rear end of a through-drive generator, comprises a standard part of the installation in the vehicle.



The largest of the fatigue machines are two for testing heavy-duty springs. Each is driven by a 12½ h.p. electric motor and can accommodate up to nine springs; the maximum dynamic load is 9 tons. Behind can be seen two machines for testing bars

Review of the Facilities and the Main Research Programme of the New C.S.F.R.O. Laboratories Situated at Sheffield

COIL SPRING RESEARCH

ALTHOUGH the Coil Spring Federation Research Organisation was established as long ago as 1945, it has not hitherto had its own laboratories. Until 1957, all its research work was carried out on an extra-mural basis at the universities. Some accommodation was then provided at the Sheffield laboratories of the British Iron and Steel Research Association, with which the C.S.F.R.O. has always been closely connected. As the volume of work increased, it became necessary to enlarge both the space and the facilities for controlled research. Consequently, a new laboratory block has recently been built, on a site adjoining the B.I.S.R.A. establishment, and it was formally opened on the 24th March by Sir Harry Melville, K.C.B., F.R.S., the Secretary of the Department of Scientific and Industrial Research.

The C.S.F.R.O. now has a membership of nearly 100. About half of this total are spring manufacturers, and therefore qualify for full membership; the remainder, associate members, are in the supplier or user industries. It is expected that the number of associate members will increase as the research programme in the new laboratories gets under way. The Organisation already gets an annual grant from the D.S.I.R., but its growth may soon be sufficient for it to be granted full Research Association status, thereby taking its place among over 40 such associations in the Government scheme.

On the ground floor of the new two-storey block are the reception hall, heavy fatigue testing and mechanical testing laboratories, electroplating laboratory, workshop and store, and also the heat treatment section, which contains a number of fully instrumented electric furnaces. The first floor comprises office accommodation, conference room, physics laboratory and laboratories for the preparation, etching, microscopical examination and photomicrography of metallographic specimens.

In the fatigue and mechanical testing laboratories, which cover more than half the ground floor area, is a comprehensive range of machines for testing large and small springs, specimens and wire. Among the interesting structural features of the section for heavy fatigue testing are the measures taken to prevent the transmission of vibration to the remainder of the structure. The foundation blocks of the machines are insulated from the concrete floor by a ¾ in thickness of Mascolite material, a similar thickness of which is used between the floor and the wall foundations. Between the walls and the floor above this laboratory is additional Mascolite material, ½ in thick. Soundproofing between the laboratory and the entrance hall is effected by double doors, and all the windows are double glazed for the same reason.

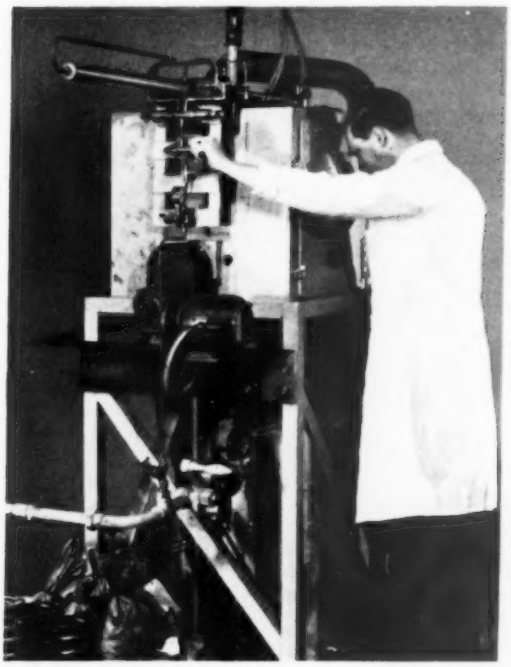
Among the more unusual fatigue testing machines are two for work on large springs. Each of these machines, powered by a 12½ h.p. electric motor, can accommodate up to nine springs at a time, and can apply a dynamic load of up to 9 tons. As can be seen from the accompanying illustration, the springs are installed in canisters carried radially above a nonagonal, horizontal bed plate. By means of swivel pins, the inner ends of the canisters are attached to a throw-plate on the crankpin of a crankshaft. The axis through the journals of this crankshaft is coincident with the vertical axis of the bed plate. As the crank rotates, it applies a reciprocating load to the springs: it is driven at 140 r.p.m. by the motor and reduction gearing.

On to the outer end of each canister is screwed a cap, which forms one abutment for the spring. The inner abutment comprises a phosphor-bronze disc, which is attached to a guide rod passing through the spring and the end cap. There is sliding clearance between the disc and the canister, and between the rod and the cap. The outer end of the guide rod is screwed into a trunnion that swivels in half-bearings mounted in a lever, which is of fabricated construction.

This trunnion is positioned near one end of the lever, which rests against a vertical knife-edge carried in a bracket bolted to the body of the machine. The load applied by the test spring is resisted by a nest of balancing springs at the other end of the lever. In series with the motor circuit is a switch controlled by this balanced system. The required minimum load on the test spring is adjusted by screwing the guide rod into or out of the trunnion, after which the balancing springs are adjusted to counteract that load. If the minimum load should decrease during the test, due to setting or failure of the test spring, the balancing springs

operate the switch, and the motor is stopped. Two types of spring canister are employed: in one instance the maximum spring size is 41 in × 4 $\frac{3}{16}$ in outside diameter, and in the other it is 15 $\frac{1}{16}$ in × 6 $\frac{1}{4}$ in outside diameter.

Small coil springs are fatigue tested in batches on high-speed machines that, in essence, consist of a camshaft and two opposed series of tappets, through which the reciprocating loading is applied to the springs. A stroboscope is used where necessary to study the behaviour of the springs in action. Speeds of up to 4,000 c/min are obtainable. On these machines, an ingeniously simple device is employed to stop the motor when a spring fails. This device comprises an insulated tube containing a spring-loaded ball, which is connected to a low-tension electricity supply. In the end of the tube remote from the spring is a metal cap. Normally, the spring in the tube is compressed by an insulated plunger, the rod of which passes through the metal end cap and is loaded by the test spring. Failure of the test spring results in the ball-spring pushing the ball along the tube against the end cap. This contact completes the electrical circuit to the cut-out relay.



Other machines are used to investigate rotating and bending fatigue in spring wire, torsional fatigue in cylindrical specimens, and the hardness, tensile and torsional properties of various spring metals. In view of the marked effect of shot peening on the fatigue life of springs, special peening equipment has been installed: the plant automatically rotates the object under treatment while traversing it with the shot stream. Two interesting techniques have been evolved in connection with shot peening. One of these is for measuring the intensity of the peening: the peening is applied to one side of a flat strip of carbon steel, and the compressive stresses induced by it cause the strip to bow. The deflection is measured by a gauge and is a function of the peening intensity.

The second of the techniques is for the measurement of the stresses induced by shot peening. A cylindrical bar is peened, as a result of which its length is slightly increased. This increase in length is measured, after which the specimen is subjected to repeated etching processes, to remove successive layers of metal from the surface. The induced compressive stresses are thus released step by step. At each stage, the change in length of the bar is determined, and from the dimensional changes it is possible to compute the stress distribution existing in the specimen before the etching process commenced.

Programme of research

The general research programme is formulated by the Research Committee from proposals submitted by members. This method ensures that effort is concentrated on those problems of real importance to the industry. At present, the programme comprises ten projects, a brief survey of which is given in the following paragraphs.

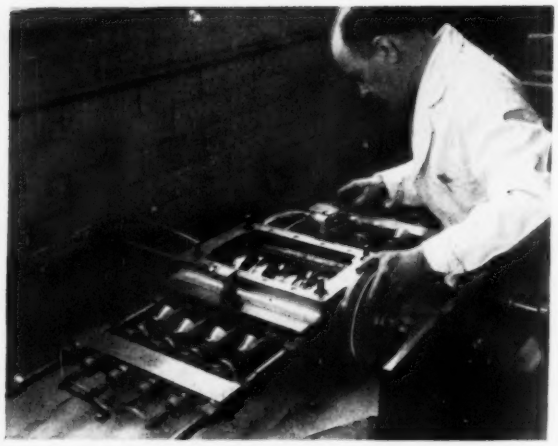
A considerable influence is exerted on the physical properties of spring steels by their hardenability. Investigation is therefore being made of this influence in relation to the static and dynamic torsional properties of various materials. Also, the heat treatments necessary to provide the optimum hardenability are being determined. The Fighting Vehicle Research and Development Establishment has sponsored an allied project, which is to study the effects of the type of material, heat treatment and surface treatment on the fatigue life of heavy-duty springs. Some of the springs employed on fighting vehicles are of a considerable size, and the heaviest manufactured for these tests have the following particulars: length, 20 in; outside diameter, 4 $\frac{1}{2}$ in; bar diameter, 1 in; rate, 1·35 tons/in.

Since stainless steels are coming into increasing use for special-purpose springs, the effect of cold work and low-temperature heat treatments on the physical properties of wires of these materials is being studied; also, the tensile and

Above: A considerable amount of research work has been carried out on the effect of shot peening. The apparatus shown here automatically revolves the item while it is being traversed with the stream of shot

Right: A general view of the furnace room in the heat treatment section of the new laboratories. All the furnaces are electric and relatively large items can be treated





One of two machines used for the batch testing of small springs, of the type used on engine valves. The load is applied by a camshaft and tappets, and a spring failure automatically stops the machine

torsional properties are being correlated, and the creep characteristics determined. Titanium is another material for which more spring applications are being found. In this connection, there is a project to investigate the torsional fatigue properties of titanium alloy wires that have been subjected to cold work or given heat treatment that makes them suitable for use as springs.

Shot peening equipment, already mentioned, is being currently used for investigation of the variation in fatigue properties obtained with different types and sizes of shot, and with different velocities and periods of peening. It is generally known that the reduction of fatigue life owing to corrosive conditions can be counteracted by giving a spring a protective, non-metallic coating, such as p.v.c. or nylon. The effects of such coatings are being studied extra-murally at the Imperial College of Science and Technology, London University.

Metallic coatings are, of course, used also to resist corrosive conditions, but the problem of hydrogen embrittlement arises in the case of electro-deposited metals: the hydrogen produced during the processing enters the steel, thereby reducing the fatigue life. The aims of the current research into this matter are the evaluation of methods of preventing or removing the hydrogen inclusion, and to ascertain the influence of these methods on the properties of the spring material. A plating plant, donated to the C.S.F.R.O. by W. Canning and Co. Ltd., of Birmingham, is employed for this purpose, and coatings of copper, cadmium, zinc, tin and nickel can be applied.

Another extra-mural project is the study of copper-beryllium as a spring material. This work is being done at Sheffield University, and an allied project on the static and fatigue properties of springs made from such alloys is being carried out in the laboratories of the C.S.F.R.O. Other research projects concern the determination of the effect of residual stress on the elastic and plastic properties of a variety of types of spring steel wire, also the stress-relaxation of springs made from numerous ferrous and non-ferrous materials, in order to determine their suitability for use at unusually high temperatures.

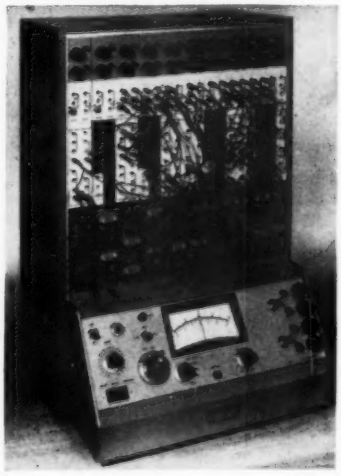
E.A.L. Analogue Computer

IN EXPERIMENTAL and research work, the great advantage of the electronic computer over traditional methods of calculation is, of course, that its use effects enormous savings in time and effort. Not only can the computer solve complex mathematical problems with speed and accuracy, but it also enables the effect of parameter variations to be studied at will over a wide range. However, the majority of analogue computers that have been developed during the past few years are relatively large and expensive. As a result, they require a permanent installation and consume a considerable amount of electrical power. Also, their use is confined to large firms that can not only afford the capital cost but can also utilize the equipment sufficiently to justify investment in it.

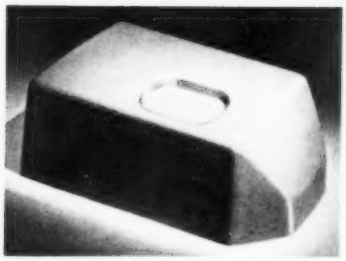
The TR10 analogue computer has been introduced by Electronic Associates Ltd. to cater for the needs of smaller companies and for those larger organizations in which it can usefully supplement the functions of the larger unit. This computer is of American origin and, by virtue of its fully transistorized layout, is small and light enough to be readily transportable. Its dimensions are $16 \times 15 \times 24$ in and its weight is 93 lb; the maximum power consumption is only 60 watts. The accuracy of the unit is $\pm 0{\cdot}1$ per cent. Because of its small dimensions and basic simplicity, the TR10 computer is considered to be well suited for on-the-spot investigation of particular projects, and for the preliminary study of problems to be investigated in greater detail later on full-scale equipment.

Apart from its linear operational elements, which can carry out addition, multiplication by a constant, and integration, the TR10 unit has a range of non-linear elements. These include quarter-square multipliers, function generators and relay comparators, which can readily be plugged in as required. The setting-up of the computer is straightforward, and the numerical values of the problem parameters are set by potentiometers, in the usual way. For depicting the solutions, an *XY* plotter, a multi-channel pen recorder or an oscilloscope can be used.

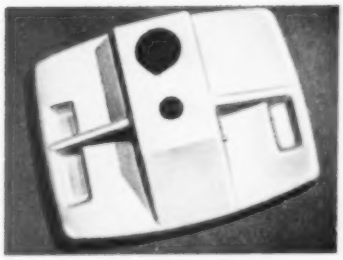
In the automobile field, the TR10 computer has obvious merits for the investigation of suspension problems, and for those involving vibrations such as could occur in, for example, a transmission system. Further details of the equipment and its possibilities can be obtained from Electronic Associates Ltd., Burgess Hill, Sussex.



The E.A.L. type TR10 analogue computer is compact and relatively simple. Its overall height is only 24 in







Three examples of the larger type of moulding produced by Fibre Form Ltd. Relatively sharp radii, ribs or pierced holes can readily be incorporated

Preformed Fibre-Resin Mouldings

Considerable Progress by Fibre Form Ltd. in the Production of Mouldings from Wood Pulp and Phenolic Resin

IN the October 1956 issue of *Automobile Engineer*, a description was given of the methods employed by Fibre Form Ltd. in the production of preform mouldings in which wood pulp and phenolic resin were the main constituents. Since then, the company's activities in this field have expanded considerably, with the result that virtually all production has been transferred from the original factory, at Trewint Street, Earlsfield, London, S.W.18, to that at Gornal, near Wolverhampton. The London unit is now engaged primarily on research and development work.

Much of the output is currently for the television and radio industries, and it is estimated that about 60 per cent of the television sets made in this country have Fibre Form moulded back panels. Suitcase shells and mouldings for the furniture and other industries comprise the remainder of the company's production, which now totals some 30,000 mouldings a week, none of which has a projected area of less than $1\frac{1}{2}$ ft^2.

Because the manufacturing process is essentially suited to large-scale production, the Fibre Form sales organization is turning its attention increasingly to the automobile industry. To ensure the availability of adequate capacity to meet the expected demand from this and other sources, additional plant has recently been installed at the Gornal factory. Moreover, a new bay, having a floor area of 15,000 ft^2, is in the course of erection.

In general, the production methods employed by Fibre Form Ltd. are as described previously, except that pulping machines are now employed, instead of beaters, in the preparation of the slurry. This slurry is made from wood pulp, in the form of kraft sheet obtained from Scandinavia, together with water, the phenolic resin, colouring matter, and precipitating and wetting agents. The properties of the moulding depend largely on the relative quantities of kraft and resin, and on the duration of the pulping process.

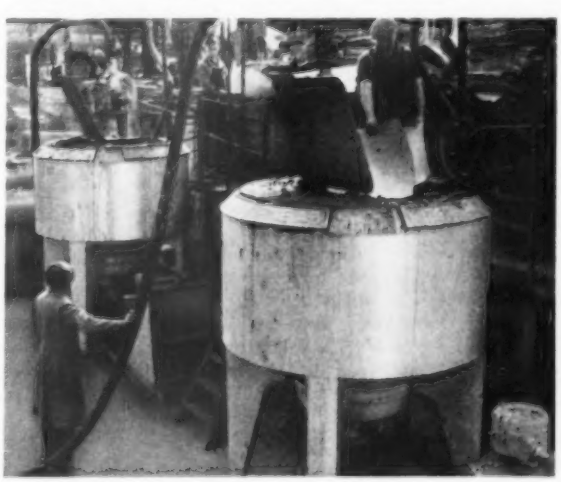
For the preforming operation, the slurry is transferred to large vats, where it is kept agitated by compressed air. The preforming tool is made of metal and is perforated for drainage. Within it is mounted a wire mesh screen, of approximately the shape of the final moulding, and it is connected to a vacuum line. The tool is lowered into the slurry and the suction turned on; by varying the immersion time, the thickness of the felt—as the preform is called—can be controlled. When the tool emerges from the vat, a predetermined draining time is allowed, with the vacuum still applied. This complete cycle is automatically controlled.

The felt, which is strong enough to be handled carefully, is then transferred to a rack. When a rack becomes full it is moved into an oven, in which the moisture is dried out of the felts and the resin is partially cured; the felts remain there for several hours, the actual period depending on their size and constitution. On removal from the oven, the felts are ready for the final moulding process.

Normally, the lower tool of the moulding press is heated to about 320 deg F, the upper one to rather less. Because the process is one of homogenization rather than forming, and virtually no flow takes place, pressures are relatively low — between 500 and 800 lb/in^2. The edges of the moulding are trimmed by the press, which is opened several times during the cycle to release the steam and evaporated volatile constituents from the resin. An average cycle time for the press operation is about 2 min. Each moulding is given a visual inspection, on removal from the press, for blistering or other faults. Once a production run has been correctly planned in terms of constituents and cycle times, however, rejects are very few.

The thickness of a finished moulding is normally between 0·050 in and 0·125 in. Thinner sections are sometimes practicable but tend to lack rigidity. The specific gravity

Two of the pulping machines that prepare the slurry for the preforms. The properties of the mouldings are governed largely by the relative proportions of the wood pulp and the phenolic resin used in the slurry





The final moulding and curing process is effected in presses, the tools of which are heated. A line of these presses, and a number of preforms and also finished mouldings, are illustrated here

of the fully cured material is just over unity and its strength : weight ratio is comparable with that of glass-reinforced polyester resin. It follows that the weight of a given component of the Fibre Form material would be about a third that of its counterpart in steel.

Because of the preforming technique employed, relatively deep shapes can be moulded without any marked local reductions in thickness or strength. Although really intricate mouldings cannot be produced, a fair degree of complexity is practicable, as can be seen from the accompanying illustrations. A disadvantage in comparison with certain other materials and processes is that inserts for reinforcement or attachments cannot as yet be incorporated, nor can the section be appreciably thickened in areas of higher stress. Considerable strength can, however, be obtained by the incorporation of ribs; again, as in the case of polyester-glass, the shape of the item can have an important effect on rigidity, a point that has to be borne in mind at the design stage. The material can readily be pierced after curing—this process leaves very clean holes—and can be machined if desired. Without any surface sealing, water resistance is adequate for many purposes, though some absorption and swelling do occur during prolonged immersion.

In many applications, the production costs of Fibre Form components should show an advantage over those of the steel equivalent. The raw materials are cheap and plentiful, and the press equipment is not unduly expensive, because of the low moulding pressures required. Relatively thin sections can be used because of the high strength : weight ratio, and this results in short curing cycles. Since the labour content of the cost of an item does not increase substantially with its size, the process is particularly suitable for mouldings of medium or large size; about 30 in square represents the present upper limit of the company's press capacity, but this is being increased to approximately 36 in square.

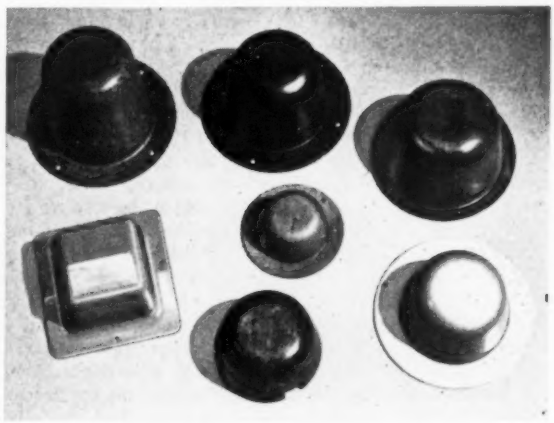
The surface of a finished moulding, though quite smooth, has a mottled, greyish appearance; hence, some form of surface treatment would normally be necessary for any automobile component exposed to view. There are several satisfactory methods of obtaining a decorative finish, and the choice depends partly on economics and partly on styling and conditions of usage. A variety of paints can be applied, and stoving can be effected at up to 180 deg C without detriment to the physical properties of the moulding. The only difficulty in painting is that due to variations in the surface absorbency : because of the greater degree of compression that occurs round sharp radii during moulding, the material is less absorbent in such regions than on flat or mildly curved parts.

A more conspicuous finish can be obtained by bonding a wood veneer, or a sheet of decorative paper impregnated with melamine type resin, to the preform before the final moulding process. This gives excellent results but, owing to the lack of elasticity of the laminate, the depth of draw is limited. No such disadvantage occurs with the third method, which is to use the vacuum forming technique to stick a thin sheet of p.v.c, or other thermoplastic material, to the finished moulding.

These three treatments are now well established, but they have recently been joined by a further method—spray coating with pigmented polyester or polyurethane resin. In comparison with paint finishes, these resins are superior in terms both of durability and of freedom from absorption difficulties, but they are also more expensive. The polyester resin coating is highly resistant to abrasion, in which respect it is rather better than polyurethane which, however, is the more flexible of the two.

There would appear to be a variety of automobile components for which the light weight, rigidity and rela-

Typical small mouldings, showing the practicability of deep shapes. An average thickness for components of this type would be about 0·06 in



tively low production costs of Fibre Form mouldings should make them worthy of consideration. Among them are transmission tunnels and body panels over gearboxes—where these do not form part of the load-carrying structure—demister nozzles, facia panels and instrument cowls, glove boxes, door pockets, parcels shelves and steering column shrouds. It has been divulged that one large manufacturer is investigating the possibilities of having moulded front seats of this material; certainly it would lend itself to seat valances and also to a variety of trim panels.

The makers have suggested that rocker gear covers would be practicable, but it is felt that the material would not have sufficient resistance to hot oil unless the surface and edges were thoroughly sealed. A possible engine application, however, would be cooling fans; adequate blade stiffness could readily be ensured by the embodiment of ribs. Since the material has good acid resistance, it could also be used for battery trays, for which duty no surface finishing would be necessary. The elimination of such finishing should clearly have a beneficial effect on production costs.

Induction Hardening Cast Iron Liners

AS is well known, hardened cast iron tends to be brittle, and therefore failures may be experienced with liners of this material for heavy duty diesel type engines. Sheepbridge Stokes Ltd, of Chesterfield, can now produce a hardened layer on the interior surface of a cylinder liner by a new method which has several important advantages over the through-hardening treatment commonly employed on cast iron liners.

The method involves the use of a radio-frequency induction heating unit, supplied by Redifon Ltd, which has a continuously variable output of from 3-125 kW at 22f Dc/sec. Power is supplied to a copper coil of square cross-section, which induces eddy current heating in the walls of the liner surrounding it. This copper coil is water-cooled, and there are perforations around its lower edge through which the coolant flows to quench the heated liner. The liner is moved axially, its speed of movement and the degree of quench being set to give a hardened layer of appropriate thickness on the bore.

This application of induction heating has several advantages for the design engineer. First, the operation is quicker and cheaper than through-hardening treatment of the whole liner. Distortion produced by induction hardening is no more than 0·003-0·005 in and this can be rectified in the final honing operation, whereas the much greater distortion produced by the through-hardening method can be remedied only by machining before honing.

Another important advantage is that, since the body of the liner retains the toughness appropriate to its soft condition, failures are less likely to occur when the liner flange is put under load. Tests carried out by the development section of Sheepbridge Stokes Ltd, consisting of dropping a 76 lb weight on to the flange at a point immediately over the undercut, have proved that there is no detectable difference between the resistance to fracture of a soft liner and that of a liner hardened to a depth of 0·060 in over its whole length. Yet another advantage is that the hardened layer can be provided exactly where required and nowhere else—for example, only the area traversed by the upper and lower piston rings.

As a result of this induction hardening treatment, the hardness of the bore is increased from 250 VPN to approximately 550 VPN. Comprehensive service tests of the liners hardened by this method are still incomplete, but the average wear on a 5·75 in diameter bore of an induction hardened liner fitted in a Caterpillar tractor engine, after running for 1,200 hours under load and 200 hours idling, was found to be only 0·001 in; the maximum wear at any one point was 0·004 in. Induction hardening has been carried out successfully on liners with 4 to 6½ in bores and up to 22 in long.

Corrosion Inhibitor

A 14-PAGE booklet on the subject of a corrosion inhibitor for vehicle cooling systems has been published by W. J. Bush and Co. Ltd, Ash Grove, London, E.8. It gives information concerning the history and development of the sodium benzoate and sodium nitrite corrosion inhibitor, which that company supplies under the trade name of Sobenite. Each of the two constituents has corrosion inhibiting properties, but their efficiency is greatly enhanced by their employment in combination. In the booklet, the methods for the determination of benzoate and nitrite, as specified in B.S. 3151:1959, are given, and the work ends with eight references to articles on corrosion inhibition.

Training for Engineers

IN November 1956 a committee was set up, by the Council of the Institution of Mechanical Engineers, to study the training of professional mechanical engineers, with special reference to the practical aspects. As a result of this committee's careful consideration of the subject, a booklet has been produced for the guidance and interest of those who are concerned with the training of mechanical engineers.

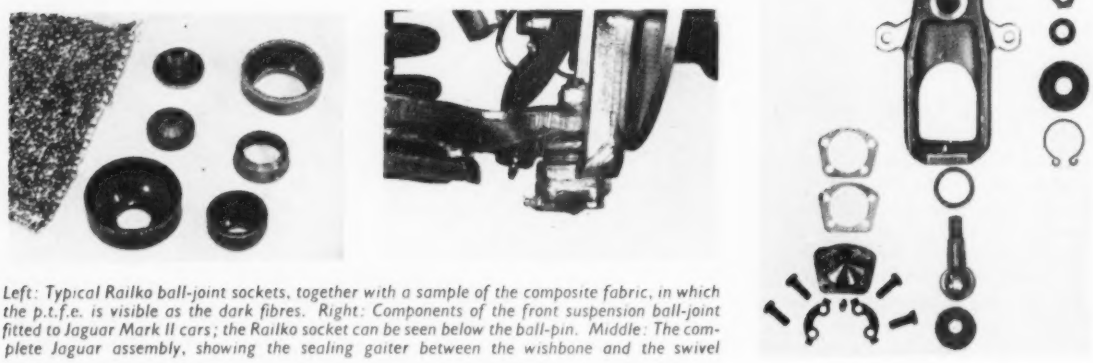
In the first six pages, general principles are discussed. Next, five pages are devoted to a secondary training of graduate apprentices, and this is followed by three pages on student apprenticeship. Finally, there is a bibliography and an appendix on the syllabus for basic workshop training. The booklet, under the title "The Practical Training of Professional Mechanical Engineers", is available, at the price of 2s 6d for members and 5s for others, from the Institution, 1 Birdcage Walk, St. James's Park, London, W.1.

Masking Tape

A NEW type of masking tape has been introduced by Metemicals (Cannon) Ltd, of 60 Cheapside, London, E.C.2. The principal merit of the tape, which is called Tesakrepp, is that it can be stretched as much as 33 per cent. With practice, by exerting more stretch on one side or the other, complex outlines and shapes can be followed with a high degree of accuracy. It is claimed by the makers that although the tape sticks firmly, by virtue of its powerful pressure-sensitive adhesive, it also strips easily and cleanly. The standard grade of this masking tape is said to withstand temperatures of up to 175 deg F. Special grades are available for use at higher temperatures or if a moisture-proof tape is required. Tapes of widths ranging from ⅜ in to 2 in are kept in stock, but other widths can be supplied.

Railko Dry Bearings

Embodiment of Polytetrafluoroethylene in Resin-Bonded Fabric Bearings; Other Types with Automotive Applications



Left: Typical Railko ball-joint sockets, together with a sample of the composite fabric, in which the p.t.f.e. is visible as the dark fibres. Right: Components of the front suspension ball-joint fitted to Jaguar Mark II cars; the Railko socket can be seen below the ball-pin. Middle: The complete Jaguar assembly, showing the sealing gaiter between the wishbone and the swivel

UNTIL about three years ago, Railko was a trade name used by Small and Parkes Ltd. for their range of dry bearings used mainly in railway rolling stock and in steel mills. In 1957, however, Railko Ltd. became a separate organization, under the control of the Birfield Group; its activities remained in general the same as under the Small and Parkes management, though further developments were envisaged. To house the new company, a factory was built at Loudwater, near High Wycombe, Bucks.

Basically, most of the Railko products are laminates, in which layers of fabric are impregnated with thermo-setting resin and bonded together under the influence of heat and pressure. Variations in the properties of the laminate over a wide range are obtainable by the use of different fabrics, resins and reinforcements. The fabrics in common use include cotton and asbestos. Among the properties of the standard materials are high strength: weight ratio, good compressive strength, relatively low frictional coefficient, ease of machining, resistance to many chemicals, ability to run dry or with a variety of lubricants, and low thermal conductivity. This last property is, of course, by no means always an advantage.

After the new factory was completed, one of the company's first projects was to investigate the possibilities of increasing participation in the automobile sphere. For this, the close integration of the Birfield Group with the motor industry was certainly responsible. Although some of the materials already developed were suitable for a number of vehicle applications, there was clearly room for new products. Considerable interest was then becoming apparent in the reduction of routine servicing by the use of unlubricated joints in suspension and steering systems; since none of the metallic materials available at that time had proved completely satisfactory in these applications, it was felt at Railko that here was a promising line of exploration.

It was soon evident that, if unlubricated laminated materials were to compete successfully with other types, a better combination of frictional and wear-resistant properties was necessary. Since polytetrafluoroethylene, or p.t.f.e, was beginning to achieve widespread acceptance as a low-friction material with good wearing qualities, its potentialities were studied. One of the interesting features of this plastics material is that fibres drawn from it are far stronger than the parent resin. Drawing raises the tensile strength from 2,000 to 47,000 lb/in^2, and the compressive strength from 2,000 to 60,000 lb/in^2. In addition, the elongation is reduced to 13 per cent, from 100-200 per cent, while the specific gravity is slightly increased from 2·2 to 2·3. The change in physical properties during drawing is due to molecular reorientation within the material, the process being roughly analogous to that occurring during the work hardening of metals.

In view of this markedly greater strength of the fibre variant of p.t.f.e, Railko's activities have been confined to this form, some particulars of which were given in the April 1959 issue of *Automobile Engineer*. Both the fibre and the resin forms are produced in the U.S.A. by E. I. Du Pont de Nemours and Company, under the trade name of Teflon. Because the manufacture of the fibres is fully covered by patents owned by Du Pont, and this company is not granting any licences owing to its own large production resources, all Railko's stocks are imported from the U.S.A. Consequently, they carry a 20 per cent import duty, which brings the price up to about £10 per lb. On this bearing project, Du Pont has co-operated very closely with Railko, much of whose earlier activities were based on development work done by Du Pont at Wilmington, U.S.A.

Initially, experiments were carried out at Railko, using Teflon fabric bonded to a laminated backing. While bearings of this sort gave excellent frictional and wear properties, they suffered from two disadvantages: the amount of p.t.f.e. used would have made them commercially unacceptable in many instances, and it was difficult to ensure a really sound chemical bond between the two components of the bearing. This bonding difficulty is a characteristic of p.t.f.e. and not of the backing materials used. In the case of the Glacier DU bearings described in the May 1960 issue of *Automobile Engineer*, it is overcome by using a mechanical bond, the p.t.f.e-lead mixture being interlocked physically with the sponge-like bronze matrix.

To overcome both difficulties at once, an interesting idea was evolved by Railko in collaboration with Small and Parkes Ltd. This idea was to embody the Teflon fibres directly in the fabric forming the top laminate of the bearing. By spinning the fibres into the yarn, full mechanical bonding could be achieved, with the advantage

that, as the top lamina wore, the proportion of p.t.f.e. exposed would remain constant. Asbestos was chosen as the most suitable yarn for the purpose because of its great resistance to heat and its excellent wearing properties in unlubricated application. Using phenolic resins for the impregnation, no difficulty is experienced in obtaining a completely reliable bond to the backing.

Frictional tests were carried out on yarns containing various proportions of the Teflon fibres. It was found that relatively small additions of p.t.f.e. markedly reduced the coefficient of friction, but that the improvement became progressively less as the Teflon content increased. On the other hand, the cost of the material varied almost directly as that content. It was, therefore, possible to select a yarn composition that resulted in a satisfactorily low coefficient of friction and an economic material cost. The yarn adopted contains approximately 20 per cent of Teflon fibres by weight, the proportion being varied slightly to suit the particular application.

While the thickness of the lamina embodying the p.t.f.e. can be varied according to the duty and the amount of wear permissible, an average figure for automobile applications would be about $\frac{1}{16}$ in. The combined material has a compressive strength in the region of 28,000 lb/in^2. Wide variations are permissible in the thickness and characteristics of the backing material, but this is usually cotton based and has a compressive strength of about 45,000 lb/in^2. It would, of course, be possible to make a component entirely of the p.t.f.e-asbestos yarn and resin, if bearing properties were required on both sides. The composite material has a coefficient of thermal expansion of 30×10^{-6} per deg F, and its conductivity is about 0·75 BTU/ft^2-sec-deg F for 1 in thickness.

As was mentioned in the article on the Glacier DU bearings, p.t.f.e. has unusual frictional characteristics, in that its minimum coefficient occurs under conditions of high load and low speed. A comparison of coefficients with those of steel at various loads is given in an accompanying graph. Also, the friction of p.t.f.e. tends to fall with temperature rise. These properties are maintained in the compound material, although the coefficient varies somewhat with the contacting metal. The material has proved to be extremely resistant to fatigue and also to shock loading; in contrast, nylon, which has also been tried for steering and suspension joints, has been known to deform under heavy impact.

Because of this quality of minimal friction at low speeds and high loads, the Railko material is considered by its manufacturers to be best suited for intermittent duties. Provided that the conditions are suitable, however, it should give satisfactory service in continuous running. In spite of the economy effected by the departure from an all-p.t.f.e. bearing surface, the cost of an actual bearing or joint is usually rather higher than that of the equivalent metal component, but against this fact must be set the low wear rate and the simplification that is made possible by the absence of need of lubrication. As is the case with most new materials, the best all-round results are not usually achieved merely by the direct replacement of an existing component: some redesigning may be necessary to take full advantage of the properties.

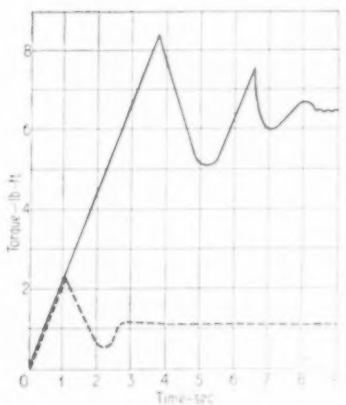
The combination of its unusual frictional qualities and the virtual absence of stick-slip make a p.t.f.e-base material particularly suitable for the ball-joints now frequently employed to provide both steering and suspension articulation. Appreciably less force, in comparison with that required with normal metal joints, is needed to overcome the initial resistance of the system to movement. Therefore, the suspension becomes more effective in absorbing small road irregularities, with a consequent reduction in the shock and fatigue loading of the vehicle, and more delicate control is provided by the steering. This effect is illustrated in one of the graphs reproduced herewith. Over larger bumps, involving higher rubbing speeds in the bearings, the higher friction of the joints is said to impart a small but useful damping action on the suspension. However, the increase in friction with rubbing speed may, of course, be partially offset by the reduction with rising temperature.

Reference was made earlier to the low thermal conductivity of p.t.f.e. itself; the low figure quoted earlier for the Railko material is attributable to the fact that the other constituents are also poor conductors of heat. This inability to conduct the heat away rapidly can be a disadvantage in certain applications. However, the bearings can operate without difficulty at up to 500 deg C, and such high temperatures are not reached in suspension joints, even in continuous running over such bad surfaces as the M.I.R.A. *pavé*.

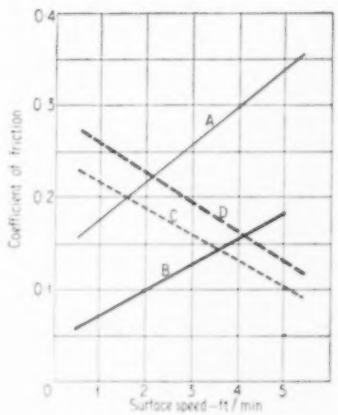
The first adoption of this material for the suspension ball-joints of a production vehicle has been made by Jaguar Cars Ltd: on the 2·4, 3·4 and 3·8 Mark 2 models, Railko sockets have replaced the carbon sockets employed on the earlier series cars. As a result of the suspension modifications embodied on the Mark 2 cars, the ball diameter is $1\frac{1}{2}$ in, as against the previous $1\frac{1}{4}$ in, and the housing has been redesigned to accommodate this larger ball and the Railko socket. The new joints are stated to have satisfactory friction qualities, and tests have indicated that the wear rate should be low. Most of the larger manufacturers of cars are at present carrying out tests of the material, in a variety of applications.

In the automotive field, there are numerous applications of the earlier Railko materials which, of course, are supple-

Right: Graph comparing the initial torque characteristics of a normal, lubricated type of ball-joint, full line, and an unlubricated one with a p.t.f.e. socket; the reduction in friction and stick-slip resulting from the employment of p.t.f.e. is very pronounced



Far right: There is a very marked difference between the frictional properties of p.t.f.e. and steel bearings. Curves A and B show the friction : speed relationship of p.t.f.e. dry bearings at 250 and 1,000 lbf/in^2 respectively, whereas curves C and D are the corresponding ones for normally lubricated steel bearings



mented and not superseded by the p.t.f.e. composition. Among these applications are unlubricated suspension bearings on trailers, timing gears in commercial vehicle and motor-cycle engines, fan and water pump bearings, fuel injection pump couplings on diesel engines, and spring eye bushes. On production machinery, one of the largest uses is for the bearings in steel rolling mills. Other duties for which the various grades are suitable are segments in drop stamps, guides, and the formers for aluminium spinning.

There are six standard grades to suit the wide variety of potential uses, including one that is impregnated with colloidal graphite, and another for specially moulded shapes only. Tensile strengths range from 4,500 lb/in^2 to 29,000 lb/in^2, and the corresponding figures for compressive and shear strengths are respectively 4,000 to 45,000 lb/in^2, and 3,000 to 15,000 lb/in^2. Coefficients of friction naturally vary with the conditions of use, but values of 0·01 or even less are obtainable in certain water lubricated duties.

New Flexible Tubing

UNDER the trade name of Vacuflex, a new type of corrugated flexible piping has recently been introduced by Recon (Pipelines) Ltd., Albert Drive, Sheerwater, Woking, Surrey. This company is an associate of Creators Ltd., of the same address, an organization well known in the plastics world. The constructional principle of this piping was invented in Germany, but Creators Ltd. evolved greatly improved production methods and so were granted exclusive distribution rights for the issue of manufacturing licences throughout the world. Recon (Pipelines) Ltd. was formed to manufacture and distribute the piping throughout Great Britain.

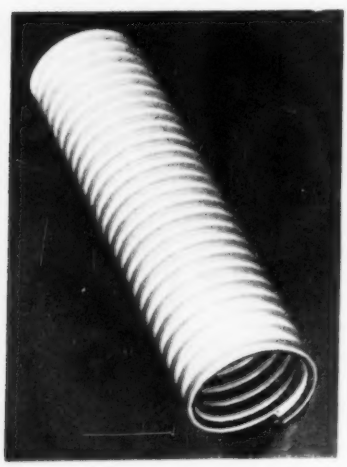
The foundation of Vacuflex hose is a helix of spring steel wire. A plastics covering is employed, and the patented feature of the design is the laminated construction of the covering. The wire itself has an extruded coating, and the main cover is, in effect, a helical profiled strip wound with overlapping edges. This overlap occurs immediately over the wire, so there is a triple thickness of the covering in this area, to give maximum resistance to abrasion. At the troughs in the corrugation, however, there is only a single thickness; as a result, the material has sufficient flexibility to permit bends to be made to an inside radius equal to the radius of the pipe. The laminations are bonded together, so avoiding any risk of separation or leakage.

An unusual feature of the production methods is that a steel mandrel is not required. Where such mandrels are used, as in the manufacture of other types of spring reinforced hose, it is not normally economic to produce lengths of more than 12 to 14 ft. The Vacuflex technique, however, which was developed by Creators Ltd., permits continuous lengths of up to 200 ft to be produced.

According to the duty and the conditions of operation, the covering can be of p.v.c., polypropylene, nylon or high-density polythene. Should greater strength be required, the p.v.c. covering can be reinforced by paper or by fabrics such as nylon, Terylene, glass, cotton or rayon. Some of the hose made has a density less than that of water, and yet can withstand boiling water or steam. Other versions, with a nylon outer covering, have been produced in which the steel wire is replaced by a nylon filament.

For the manufacture of Vacuflex hose, six machines have been built in a period of eight months, and an additional twelve are being prepared. The size range of tubing at present available is from 1 in to 4 in bore, but it is intended to extend this range upward to 8 in and downward to $\frac{5}{8}$ in. A new factory is being built at Sheerwater to enable the production capacity to be increased.

Vacuflex hose has obvious possibilities for many industrial purposes, for the conveyance of liquids, gases and vapours, and also as a conduit for electric cables. It would also appear to be admirably suited to heating and ventilating duties in vehicles. In this connection, it has been adopted by Vauxhall Motors Ltd. for the demisting equipment on certain commercial vehicles. Another automobile application is its use by the Standard Motor Co. Ltd. for the connection to the air filter. Full technical details of the tubing are available from the manufacturers.



This view of a sample of Vacuflex flexible tubing illustrates the laminated construction. A variety of covering materials is offered by the makers

Fifty Years of Component Manufacture

CONTINUED FROM PAGE 367 OF OUR SEPTEMBER ISSUE)

Even adhesive tape is an essential material for motor vehicle manufacture. Just over 50 years ago, John Gosheron and Co. Ltd. started with small premises in Fleet Street, introducing gummed paper tape to an extremely sceptical market of string and sealing-wax users. Self-adhesive tapes first came on the market after the 1914-18 War, and they took the form of cloth tape to which was bonded a dense adhesive mass. Even before that, multi-coloured cotton tying tapes had been gradually gaining acceptance. In 1932, the firm, which had previously moved to Golden Lane in the City, was transferred to Beech Lane, E.C.1, and by 1936 it had introduced cellulose self-adhesive tape to industry.

During World War II, waterproof plastics tapes were developed for the government: several materials were used, including acetate, ethyl cellulose, vinyl, waterproof cloth and paper masking tapes. At the same time, the technique of printing on self-adhesive tapes was introduced. In 1940, the premises at Beech Lane were destroyed by enemy action and the company moved to Shepherds Bush.

For electrical applications, p.v.c. and polythene tapes were introduced in 1951-52 and at the same time printed self-adhesive labels were introduced. By 1955, further expansion was necessary to meet the demands, so John Gosheron and Co. Ltd. moved to their current premises, The Packaging and Industrial Tape Centre, Albert Embankment, Vauxhall, S.E.11. For the motor industry there are now 11 different grades of masking tape, and there are other types for protection, cushioning, repair work, insulation, identification, and additional duties such as coding and advertising.

Recent Publications

Brief Reviews of Current Technical Books

Metal Industry Handbook and Directory 1960

London: ILIFFE AND SONS LTD, Dorset House, Stamford Street, S.E.1. 1960. $8\frac{1}{4} \times 6$. 584 pp. Price 21s.

The Metal Industry Handbook and Directory has gained world wide recognition as a standard work of reference and a comprehensive source of information to all those engaged in, or connected with, the non-ferrous metal industries. Up-to-date information on the properties of the newer as well as more familiar metals is given, and the extensive section devoted to summaries of British Standard materials for aircraft, D.T.D. and Admiralty specifications has again been included.

A wide range of producers, stockists and factors of all basic metal products, metal working machinery and tools, and metal finishing equipment is listed in the directory for buyers. The Handbook also includes a section on the chief metal finishing processes, and data regarding all the common rod, bar, sheet and strip products. All who manufacture, use or deal in non-ferrous metals will require this up-to-date information, which is conveniently presented in one annual volume and which is now in its 49th year of publication.

There are four sections in the Handbook. The first is on the general properties of metals and alloys. In the second there are general data and tables, while the third is devoted to electroplating and allied processes. Finally, there is a directory giving the following information: trade names; metal and allied trades associations and societies; scientific and technical institutions; directory of buyers; and a list of addresses.

British High-Speed Diesels

By C. Morgan-Jones

London: TEMPLE PRESS LTD, Bowling Green Lane, E.C.1. 1959. $8\frac{1}{4} \times 5\frac{1}{2}$. 162 pp. Price 15s.

Covering the general operation and maintenance of diesel engines up to 400 b.h.p. for automotive, rail and industrial purposes, this is essentially a practical handbook. It explains in non-technical language how a high-speed diesel engine works, what causes it to go wrong, and how to correct running faults and to avoid unnecessary stoppages. The work covers British high-speed diesel engines of all classes, two-stroke and four-stroke, used in the applications already mentioned.

The list of contents is as follows: The modern high-speed diesel engine and how it works; Trouble shooting; Starting; Fuel systems; Governors; Pistons and piston rings; Cylinders; Valves; Crankshafts and frames; Lubrication and cooling; Air-inlet and exhaust systems; Pumps and drives; Operating premises; Maintenance.

Trader Handbook 1960

London: TRADER PUBLISHING COMPANY LTD, Stamford Street, S.E.1. 1960. $8\frac{1}{2} \times 5\frac{3}{4}$. 762 pp. Price 21s.

This book provides essential information for manufacturers, trade suppliers and repairers of motor, motor cycle and cycle goods. By virtue of its practical and comprehensive treatment of every aspect of these industries it forms a useful work of reference for answering questions that arise in connection with buying, selling and servicing throughout the year. It will also prove of great value to firms overseas seeking contact with British suppliers.

Technical information in the Handbook includes specifications of all types of motor vehicles and servicing data for cars and goods vehicles. The comprehensive buyers' guide gives names of manufacturers of components, accessories and transport service equipment bought and sold in the motor, motor cycle and cycle industries, while the proprietary names section identifies the makers of over 5,000 branded goods.

Included with a mass of general information are oil producers' grades; spares, repairs and specialist services; trade associations; index of vehicle registration numbers; motor cycle cable data; motor cycle and cycle lamp bulbs; brake lining dimensions; bicycle hub dimensions; cycle repair charges. Wholesalers are given in lists arranged alphabetically and territorially. An additional feature which will prove of value to moped dealers is a list of moped repair charges on a time basis.

The Trade Addresses section has been revised and lists all manufacturers, concessionaires, distributors and wholesalers mentioned in the Handbook, giving their postal and telegraphic addresses, telephone numbers and, where possible, the name of the firm's sales and service managers.

Welding Handbook

Edited by A. L. Phillips

London: CLEAVER-HUME PRESS LTD, 31 Wright's Lane, Kensington, W.8. 1960. 9×6. 500 pp. Price 72s.

The fourth edition of Section III of the Welding Handbook is now available. It deals with special welding processes and cutting. Modern industrial progress and the new technological developments that have occurred with such fantastic speed in recent years have had a tremendous effect upon the welding industry; in fact, the last ten years have probably shown the greatest development in the history of this branch of engineering.

For the work under review, the material has been obtained from experts in each particular field, irrespective of their country. This degree of international co-operation has been greatly helped by the modern trend towards standardization. The new edition contains chapters on adhesive bonding and the welding of plastics. This represents a major departure from the previously established policy of the American Welding Society, in that it is the first time the Society has recognized adhesives as structural materials, at least so far as their Welding Handbook is concerned. As is inevitable, the chapter on adhesives is heavily slanted towards aircraft engineering. However, many of the techniques used in the aircraft industry can be used by others. Ultrasonic welding is another subject that is new to the handbook: with this process no heat source is needed and only a low pressure is required, so a metallurgical bond is obtained without surface deformation.

The list of chapters is as follows: Forge welding; Thermit welding; Induction welding; Surfacing; Metal and ceramic spraying; Brazing; Soldering; Welding of plastics; Adhesive bonding of metals; Oxygen cutting—auxiliary oxygen cutting processes; Arc cutting; Ultrasonic welding; Welding by cold working; Stud welding.

Air Pollution Control

By W. L. Faith

London: CHAPMAN AND HALL LTD, 37 Essex Street, W.C.2. 1960. 9×6. 259 pp. Price 68s.

In recent years the nuisance and, in some instances, the dangers of polluted air have come to be seriously considered. Obviously the first step towards effective action to remedy the situation is the acquisition of scientific knowledge of the nature of the problem. The book under review is intended to present the basic facts. It is not directed solely at the specialist: rather has the author attempted to discuss the problems in language that can be easily understood by both the intelligent layman and the specialist.

The work begins with an explanation of the effects of air pollution and the importance of meteorological variables. A discussion of the nature and source of the more common air pollutants follows; then detailed consideration is given to methods of determining the amounts of the various contaminants in the air, the most appropriate means of controlling emissions at the source, and the legal measures that can be taken for control. A chapter is devoted to the automobile exhaust problem, and radio-activity is also dealt with. The work is not intended for those who seek a comprehensive treatise on the subject but is for those who want a better understanding of the more common problems.

There are nine chapters and an appendix that contains conversion factors for common air pollution measurements. The list of chapter headings is as follows: The air pollution problem; Meteorology; Smoke; Dusts, fumes, and mists; Gases; Odours; Automobile exhaust; The air pollution survey; Legal aspects.

High Productivity in Heavy Engineering

By A. G. Thompson, B.Sc., A.M.I.C.E., M.I.E.S., A.M.I.W.
London: ILIFFE AND SONS LTD, Stamford Street, S.E.1. 1960. $8\frac{1}{4} \times 5\frac{1}{2}$. 339 pp. Price 65s.

The introduction of welded fabrication into heavy engineering has led to the development of a whole range of new techniques. These techniques have revolutionized the production methods of many firms and indeed of complete industries, of which shipbuilding is an outstanding example. In addition, the development of the modern oil industry and commercial nuclear power has been largely dependent on new techniques, many of which also find application in the manufacture of pressure vessels, liquid storage containers, machine and engine frames, and in structural engineering.

In this book, the aim has been at avoiding, so far as possible, a repetition of what has already been published on welding. In the main it is about the technology that has been built up around welded fabrication—accurate dimensioning, coding, methods of transferring dimensions, and cutting machines, including computer-controlled flame profiling machines using punched or magnetic tape, and welding machines. A large chapter deals with the latest metal-working processes essential for efficient fabrication, and includes details of the various machines that have been specially evolved for pre-forming sheet and plate. Other chapters deal with shop layout; assembly and handling; and quality control and inspection, in which information is given on the latest methods of non-destructive testing.

The second half of the book is devoted to costing methods appropriate to heavy fabrication. There are four chapters on various aspects of this subject; they include one on productivity improvement, which illustrates, by examples taken from heavy engineering, the specialized approach that is necessary. This well illustrated book, by an industrial consultant who has made a particular study of this highly specialized subject, will be invaluable to all those responsible for the fabrication of metal by welding: this includes management, engineers, designers, production and planning staffs. Students of all branches of engineering should also find much in it to interest them.

The contents are as follows: Introduction; Layout and organization of modern fabrication shops; Dimensioning for accurate fabrication; Metal working processes; Assembly and handling; Welding processes; Quality control and inspection; Cost in relation to output; The time to do the job; Use of cost data; Productivity improvement; and Index.

Kempe's Engineers Year-Book for 1960

London: MORGAN BROTHERS (PUBLISHERS) LTD, 28 Essex Street, Strand, W.C.2. 1960. $7\frac{1}{2} \times 5$. 2,738 pp. Price 87s. 6d.

This well known Year-Book has been revised to cover the recent advances in science and practice of engineering. There are more than 120 pages of new tables and text. Completely new sections deal with: Electronic engineering; Nuclear power—this replaces the earlier chapter on atomic power; Pre-stressed concrete; Diesel locomotives and rail cars; Railway brakes; Railway signalling; and Naval architecture. Other additions refer to high temperature steels; cutting tool coolants; ceramic tipped cutting tools; tube bending machines; machinery skids; dolly trucks; high-pressure flow meters; fatigue testing machines; base exchange process of water softening; slewing rings; N.C.B. coal classification tables; boilers and boiler furnaces; and performance of refrigerants. Other alterations have been made owing to the issue of new and revised British Standards.

Plastics Progress 1959

London: ILIFFE AND SONS LTD, Stamford Street, S.E.1. 1960. $9\frac{1}{4} \times 6$. 216 pp. Price 55s.

All the technical papers read at the International Plastics Convention at Olympia, June 1959, are presented in this book. They include reports of new work on polypropylene, epoxides, the cross-linking of thermoplastics, graft and block copolymers, expanded plastics, and extrusion. The work also contains a survey, by experts in Europe, the United States and the United Kingdom, of recent thinking in the glass reinforced plastics fields. The texts of the papers are considerably longer than the versions that the authors had time to present at the convention itself, and a review of the discussions which followed them is also included.

The contents are as follows. Polypropylene: physical and mechanical properties of polypropylene, the moulding characteristics of polypropylene, and a discussion on polypropylene. Material developments: some new epoxide resin systems and their properties, cross-linking of thermoplastics after fabrication, some theoretical and experimental aspects of block and graft copolymers, and a discussion on material developments. Recent developments in glass reinforced plastics: the progress of glass reinforced plastics in the Benelux Countries, progress in Germany, progress in the United Kingdom, progress in the U.S.A, discussion on recent developments in glass reinforced plastics. Expanded plastics: U.S. developments in foamed plastics and in particular foamed smokes, bulk density and physical properties of expanded polystyrene, and a discussion on expanded plastics. Extrusion: extrusion studies on thermoplastics, the extrusion of acrylics, and a discussion on extrusion.

The British Engineers' Handbook

London: THE BRITISH ENGINEERS' ASSOCIATION (INC.), 32 Victoria Street, S.W.1. 1960. $8\frac{1}{4} \times 5\frac{1}{2}$. 608 pp. Price 21s.

As is well known, The British Engineers' Handbook is published annually by The British Engineers' Association (Inc.). It contains an alphabetical list of members, giving their full names, addresses, telephone numbers, telegraphic addresses and codes, together with their range of products and, in many cases, additional information such as branch offices, overseas agents and subsidiary companies. In Section II, many of the members illustrate their products by means of display announcements. Section III is a classified list of manufactures under more than 3,000 headings. Indexes to these headings are also given in French, German, Portuguese and Spanish. Section IV comprises a list of trade names and marks.

The Autocar Handbook

By J. R. Singham, Ph.D., B.Sc.(Eng.), A.M.I.Mech.E.
London: ILIFFE AND SONS LTD, Stamford Street, S.E.1. 1960. $8\frac{1}{4} \times 5\frac{1}{2}$. 273 pp. Price 12s. 6d.

The Autocar Handbook has been the recognized guide for over 50 years for the owner-driver who, to obtain the maximum benefit and enjoyment from his car, wants a clear picture of how it works. From time to time, it has been necessary to rewrite the book completely, owing to major advances in design: this is such an occasion. The current edition gives an absolutely up-to-date account of the car of today, written in a modern style, and is easy and interesting to read.

With a few exceptions, the illustrations have been specially drawn for this new edition by the staff artists of our associated journal *The Autocar*. Wherever possible they have been made three dimensional, and every care has been taken to ensure that they can be followed by both technical and non-technical readers. Of exceptional interest are the cut-away drawings of particular cars and engines, which are such a popular feature of *The Autocar*.

Every part of the car's structure and mechanism is described in a logical sequence in simple semi-technical language, and each of the 22 chapters is complete in itself, so that it is possible to read any one chapter without reference to others. Among recent developments covered are automatic transmission systems, other two-pedal control arrangements, disc brakes, overdrives, power assisted brakes and steering, and fuel injection. With the basic knowledge of motor cars and their components provided by this handbook, the owner can be sure of getting the best out of his particular model, can recognize and diagnose simple faults and maladjustments before damage is done, and can save the costs of inefficient running and unintentional neglect.

The contents are as follows: Foreword; A brief survey; Fundamentals of the petrol engine; The popular overhead valve engine; Engine design features; Producing the mixture; Producing the spark; The petrol supply; Engine lubrication; Engine cooling; The clutch; Making use of the engine; The drive to the road wheels; Two-pedal control; Automatic transmission; Alternatives to the petrol engine; Wheels, tyres and brakes; Suspension, springs and shock absorbers; Steering; The body structure; Body details; The electrical system; and Equipment and accessories.

The Modern Diesel

By Donald H. Smith, M.I.Mech.E.
London: ILIFFE AND SONS LTD, Stamford Street, S.E.1. 1959. $8\frac{1}{4} \times 5\frac{1}{2}$. 288 pp. Price 17s. 6d.

Although the great swing to diesel usage during the last few years is particularly evident in the medium-capacity classes of goods vehicles, a number of truly small diesels have also appeared on the market. The 1-ton delivery van, small agricultural tractors and marine vessels, and a considerable proportion of British taxi-cabs are all equipped with diesel engines. With the conversion of the railways well under way, the diesel power unit can be said to dominate the transport scene. One field remains to be conquered: it is that of the popular car. Research into the elimination of diesel knock by means of pilot injection may remove at least one major obstacle.

Modifications are constantly being made in all applications. The latest trends in fuel injection practice, combustion chamber design and fuel lubricant developments are reviewed in this, the thirteenth and largest edition so far of this work. This volume—now brought completely up-to-date—is a handbook which, through successive editions since 1932, has provided detailed information on the characteristics of current diesel engines, and a comprehensive account of the automotive type unit is included.

The application of each class of engine is considered in relation to the requirements of road transport, railway, tractor, industrial and marine services. Comprehensive reviews of the principal British, American and Continental engines available in these fields are included, together with illustrations and significant data. The engines of over 70 manufacturers from 11 countries are described.

At the end of the work is a chapter covering the problems of producing diesel units for the private car. There is also a table providing ready reference to the characteristics of all the British automotive-type diesels currently in production. Throughout, the treatment is such as to place the subject within the grasp of the average operator or mechanic, without in any way detracting from the book's usefulness to the engineer or student. This work also represents a historical survey of the rapid technical development that has taken place.

The contents are as follows: Development of the high-speed automotive diesel; The term diesel; General and historical survey; The compression-ignition cycle; Fuel-injection systems; Combustion chamber design; Diesel fuel and lubricants; Road transport; Automotive engines; Railway service; Tractor and industrial engines; Small air-cooled diesels; Marine service; Diesels and the private car; Appendix I: British Automotive type diesel engines; Appendix II: Metric conversion table.

Metallizing Shafts or Similar Objects

New York: AMERICAN WELDING SOCIETY, 33 West 39th Street, New York 18. 1960. 9 × 6. 32 pp. Price $1.00.

A newly revised edition of the booklet on the Recommended Practices for Metallizing Shafts or Similar Objects has been published by the American Welding Society. It is illustrated with diagrams, line drawings and half-tones, and contains six tables. The work has been prepared by the AWS Committee on Metallizing.

A new section has been introduced: it is on surface preparation for metallizing. Since the degree of surface roughness considerably affects the strength of the bond, the methods of roughening have been divided into three groups, and recommendations are given as to when to use which of the different methods. Most of the material in the booklet has been re-written to bring it up to date, and the contents have been rearranged for quicker reference. The sections are under the following headings: General; Surface preparation; Spraying; and Finishing.

V-Four Engine in Russian Small Car

THE Russian Zaporozhets (Cossack) small car originally had a 746 cm³ horizontally opposed four-cylinder engine, but the latest power unit is of 90 deg V-four layout. It retains the bore and stroke measurements, 66 × 55·5 mm, and the air cooling of the earlier engine. An article in the March 1960 issue of the Russian motoring journal *Steering Wheel* gives the reasons for the design revision.

It was felt that the superior inherent balance of the flat-four engine was outweighed by the disadvantages, among them the poor accessibility, in which connection mention was made of the necessity of removing the unit for tappet adjustment. Also, the long induction system inevitable with a single carburettor had caused difficulty in cold starting. An unusual objection to the horizontally opposed engine was of overheating of the valve gear because of mud deposition on the rocker covers during travel on unmetalled roads in bad weather.

As hitherto, the engine is mounted at the rear and, to obtain equal firing intervals, the four throws of the crankshaft are arranged in two planes. The poor dynamic balance of this layout has been corrected by the ingenious application of an old and well tried principle: an additional shaft, revolving in opposition to the crankshaft, has been introduced. Since the counterweights on the crankshaft fully balance both the rotating and the reciprocating masses, the result is a horizontal, unbalanced primary couple. The additional shaft runs within the hollow camshaft, which is immediately above the crankshaft, and it carries a balance weight at each end. These balance weights are disposed mutually at 180 deg and, similarly, balance weights are embodied in the crankshaft. The two shafts are so phased that the vertical components of the centrifugal forces acting on the weights cancel each other out, whereas the horizontal components combine to form a couple equal and opposite to the primary couple. Although theoretically sound and cleverly incorporated, this balancer must add to both the weight and cost of the engine, and it is, of course, for this reason that mechanisms of this type are not widely employed in motor vehicles.

An interesting feature of the lubrication system is that a centrifugal filter is embodied in the fan driving pulley on the crankshaft. It is known that the Russians strongly favour this type of filter and that all tractors now being produced are fitted with a filter closely resembling the unit designed and manufactured by The Glacier Metal Co. Ltd. The filter body is of aluminium and is radially finned for cooling.

Mounted on the dynamo spindle is the ducted, axial-flow fan that cools the cylinders and heads. It draws air from between the cylinder banks, and cored passages are employed in the blocks and heads to ensure that the induced air flow past the hot regions is adequate. Baffles are used to avoid over-cooling of other areas.

In most other respects, the engine is of orthodox design, though the oil sump is unusually wide and shallow. Since the compression ratio is only 6·6:1, the unit is obviously intended for operation on low-grade fuels. Breathing has been restricted in the interest of longevity and ability to withstand prolonged full-throttle operation. The maximum power output is said to be only 20 b.h.p. at 4,000 r.p.m. and the torque 32·5 lb-ft at the relatively low speed of 2,400 r.p.m, corresponding to a b.m.e.p. of 106 lb/in².

London Shows

COMMERCIAL VEHICLES

A REVIEW of the outstanding features among the exhibits at the Commercial Vehicle Show will be given in the next regular issue of *Automobile Engineer*, published on Wednesday, the 2nd November. As in the special issue published annually to cover the private car show, the descriptive matter will be well supplemented by illustrations showing the most interesting details. The price is 3s 6d net, the same as that of the other monthly issues.

PRIVATE CARS

The Show Review number of *Automobile Engineer* will be published on Monday, the 28th November. It will constitute a critical review of the interesting new exhibits and will have numerous illustrations of special features and design characteristics. This special issue can be obtained, by order from newsagents throughout the United Kingdom, price 3s 6d net. Readers are reminded that it is necessary to order early from a newsagent to secure a copy.

P.S.V. Heating and Ventilation

Part I: Some Aspects of Requirements in Respect of Operation of Buses, Principally in Cold Climates

HUGO BJÖRCK*

DURING recent years, a great deal of scientific and engineering research has been carried out with a view to discovering more about the factors that affect the feeling of comfort, or otherwise, that a person experiences when remaining in a room or other enclosed space for a period of time. This work has revealed that the temperature of the air is not the only factor of importance: others are the temperature of the surrounding walls, and the movement and moisture content of the air. Knowledge of these factors has led to improvements and economies in respect of the heating of houses and assembly rooms of various types, and much of the experience acquired in this field should also be taken into account when dealing with the problem of the heating and ventilation of modern buses and coaches for operation in different climates.

In this article, the author endeavours to analyse some of the basic, elementary problems involved in the heating and ventilation of diesel buses in a climate where the ambient winter temperature may be below −20 deg C (−4 deg F). For the interior of the vehicle, a constant temperature of +15 deg C (59 deg F) is required, and under severe conditions this necessitates increasing the temperature of the interior of the vehicle by 35 deg C (63 deg F).

Heat supply requirements

The total heat supply requirements of a bus or coach comprise the *transmission heat* and the *ventilation heat*. Of these, the former includes heat to replace that lost through sides, windows, floor and roof, while the latter is the heat for warming the air supplied for ventilation of the interior.

Transmission heat

Heat transfer process through the side, floor or roof of a bus can be schematically illustrated as in Fig. 1. Between the interior, at temperature t_i, and the exterior, at temperature t_u, there occurs a heat flow which is proportional partly to the difference in temperature $t_i - t_u$ ($\triangle t$) and partly to the heat transfer number k of the side, where k is in metric units and is the number of kcal/m²-hr-deg C which will pass through the relevant wall of the vehicle. Expressed in British units, $k = 1$ kcal/m²-hr-deg C becomes $K_i = 0{\cdot}205$ B.Th.U/ft²-hr-deg F. The figure k is dependent on: the heat transfer number α_i, from the interior air to the inner panel; α_u, which is that relating to the transfer from the exterior to the outer panel; and the thermal insulation in the actual bus side, which is dependent on the construction of the side.

Thus the quantity of heat W passing through the side can be obtained from the equation: $W = k(t_i - t_u) = k\triangle t$. The temperatures t_{iv} and t_{uv}, of the inner and outer panels, can be calculated from the equation $W = k\triangle t = \alpha_i(t_i - t_{iv}) = \alpha_u(t_{uv} - t_u)$. From experience it has been found that α_i and α_u can generally be taken as 7 and 20 kcal/m²-hr-deg C respectively.

A side with no insulation has a k of approximately 2·5 kcal/m²-hr-deg C, and it has been found that an inner panel, where $t_i = +15$ deg C and $t_u = -20$ deg C, has a temperature of 2·5 deg C (36 deg F). Obviously, a passenger sitting next to a panel at this temperature cannot feel warm: the human body loses heat to the cold panel by radiation, and the interior temperature seems to be far lower than the actual temperature of the air.

If the side is efficiently insulated, k drops to approximately 1. This means that, by insulating the side, the rate of heat loss will be more than halved, and, under the conditions outlined in the previous paragraph, the temperature of the inner panel will be +10 deg C (50 deg F).

For a thin floor, of wood covered with linoleum, the value of k is approximately 3. Again, under the same conditions, the temperature of the inner face of the floor will theoretically be around freezing point. In practice, it is possible that conditions are improved slightly as a result of heat coming from the engine, exhaust pipe and silencer, but despite this, when the outside temperature is low, a simple non-insulated floor will have a very low temperature and it will be impossible for passengers to feel comfortable. A person feeling the cold in his feet will feel even worse if the air is very warm at head level.

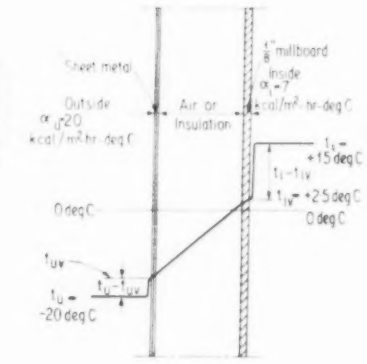


Fig. 1. Diagram of temperature gradient due to heat flow through a conventional type of uninsulated side of a public service vehicle

Windows with single panes have a k of about 5, which means that heat losses through them are high. The temperature on the inside of the glass will be −10 deg C (14 deg F). Approximately the same values apply to metal parts, such as pillars, window frames, wheel-arches and step-wells, in contact with both the air inside and outside.

Table 1—INSIDE PANEL TEMPERATURES AT DIFFERENT VALUES OF k

Ambient temperature, deg C	Inside panel temperature, deg C at $t_i = +15$ deg and k =			
	1	2	3	5
−5	+12	+9	+6	+1
−10	+11·5	+8	+4	−3
−20	+10	+5	0	−10

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Double panes in windows reduce the value of k to about 3·5 and raise the temperature of the inside of the glass by approximately 8 deg C (14 deg F). Also, double-pane windows help psychologically to increase passenger comfort since mist and ice do not form on them so readily. Mist forms into ice at about $t_u = -6$ deg C (21 deg F) on single pane windows, and at $t_u = -14$ deg C (7 deg F) on double-pane ones—a considerable difference. In Table 1 is shown the inside panel temperatures at different values of k and ambient temperatures of −5, −10 and −20 deg C.

An estimation of the transmission heat losses in the case of an 11 metre (36 ft) long single-deck bus is shown in Table 2. Estimations of this kind must, of course, be regarded as being schematic and approximate; the figures, however, should provide valid comparisons between different constructions and designs of parts. The inner panel temperatures in Table 2 are based on the assumption that $t_i = +15$ deg C and that $t_u = -20$ deg C. In Fig. 2 are typical values for temperatures experienced in insulated and non-insulated bodies. At $\Delta t = 35$ deg C, the total transmission heat quantities are:

Non-insulated body	10,300 kcal/hr	(41,000 B.Th.U/hr)
Insulated body, single pane	6,300 „	(25,000 „)
Insulated body, double pane	5,400 „	(22,000 „)

The values of k given apply mostly to bodies without sections of metal, such as pillars, that can conduct heat directly from inside to outside. The occurrence of these in any great quantity will increase the losses by 20 to 30 per cent. Furthermore, the values apply to stationary vehicles: in the case of vehicles in motion, they must be increased by 25 to 40 per cent.

It can be seen, then, that there is a considerable difference between an insulated and a non-insulated body. A higher interior temperature can, therefore, be maintained more easily in an insulated body, and this is, of course, especially beneficial if the supply of heat is limited—a condition that often prevails. The most important part to be insulated is the floor. It should be of double skin construction with insulation between the skins, to give a value of k of approximately 1. Of course, all the parts, even wheel-arches and step-wells, should be well insulated.

Insulation of metal bodies is usually unsatisfactory; some components, such as pillars and window frames, are often in contact with both outside and inside air and thus form bridges through which the heat can flow from inside to outside. This is disadvantageous in cold climates, and such bridges should, therefore, be interrupted by a layer of insulation, and screws used on the inside should not be screwed into metal in direct contact with the outer air.

Nor should it be overlooked that insulation is also of importance in hot climates: without it, large quantities of radiant heat from the sun will pass to the bus, causing the interior temperatures to rise to a level considerably higher than ambient.

In concluding this section on heat losses as a result of transmission, the author wishes to stress once again the important fact that in cold climates the temperature of the inner panels is made higher by insulation. It may be assumed, as a very rough approximation, that the temperature a person feels in a room is the arithmetical mean of the temperatures of the inner air and the walls. In the case dealt with previously, the passenger in the non-insulated body would experience an apparent inside temperature $= \frac{1}{2}(15 + 2{\cdot}5) = 8{\cdot}75$ deg C. The apparent inside temperature felt in an insulated body, on the other hand, would be $\frac{1}{2}(15 + 9) = 12$ deg C. Thus, apart from a substantial reduction in heat loss, the advantage of insulating the body is the impression that the temperature is higher, in this instance 3·25 deg C = 6 deg F, which means increased comfort.

Ventilation heat

A well designed and well built modern bus body for use in a cold climate must be so well fitted—and this includes windows and doors—that there is no draught inside when the vehicle is in motion or exposed to wind. If the body is not draught-free, completely uncontrolled ventilation may occur, and in a cold climate, this will render the vehicle useless for conveying passengers, partly because of the resulting draught and partly because the heat losses will be so great that the available heat will be insufficient to render the bus comfortable. The change of air necessary for maintaining acceptable conditions, with regard to freshness and the degree of humidity, must be effected by a well controlled supply of fresh air, sufficiently warmed in cold weather.

With regard to the volume of air available to each passenger in a bus, it should be endeavoured to maintain a fresh supply corresponding to 0·5 to 1·0 m³/passenger every minute (17·5 to 35 ft³/pass-min). The 11 metre long bus, mentioned before, has a volume of approximately 45 m³ (1,600 ft³) and, under Swedish regulations, holds a total of about 45 seated and 25 standing passengers. In normal traffic, the average percentage of places occupied is 25 to 30 per cent, which corresponds to 18 to 21 passengers. However, by way of compromise, if we estimate for 25 passengers, the total air requirements will be 750 to 1,500 m³/hr (25,000 to 50,000 ft³/hr), corresponding to 16 to 33 changes of air. Buses are full for less than 5 per cent of the time, and the conditions assumed for estimating the requirements cover 65 per cent of the time.

Experience indicates that fresh air should be supplied in such a way that there is always a slight positive pressure inside, relative to outside. This helps to keep out draughts

Table 2—ESTIMATION OF TRANSMISSION HEAT LOSSES IN AN 11 METRE LONG, SINGLE DECK BUS

	Area m²	Non-insulated body			Insulated body		
		k	t_i, deg C	kcal hr-deg C	k	t_i, deg C	kcal hr-deg C
Sides	27·5	2·5	+2·5	70	1·25	+9	35
Roof	30	2·5	+2·5	75	1·25	+9	38
Floor	25	2·8	+1	70	1·0	+10	25
Windows, single	16	5·0	−10	80	5·0	−10	80
Windows, double	16	—	—	—	3·5	−2·5	(56)
	Total, single pane 295	... ...	... ...	... ...	... ...	... ...	178
	Total, double pane —	... ...	... ...	... ...	... ...	... ...	154

and the seeping in of fuel oil smells and exhaust gases. However, it is important that the used air can escape without meeting undue resistance. Sufficiently large outlets should be provided for this purpose, and their arrangement should be such that they cannot be closed. This is essential if the required quantity of air is to be introduced into the interior of the vehicle.

The supply of fresh air is a vital factor in the regulation of the humidity of the air in the bus. Each passenger adds approximately 30 gm/hr (1·1 oz/hr) of water to the air, but in rainy and misty weather, large quantities of moisture are added to the air in other ways, creating problems outside the sphere of normal conditions. If we still calculate on the basis of 25 passengers, the normal amount of moisture to be removed by ventilation will be 750 gm/hr.

To avoid mist from forming in the vehicle, the dew-point of the air must not exceed the lowest inner panel temperatures. In the calculation example, the temperature on the inside of the single pane windows will be −10 deg C and, therefore, in order that they shall be free from mist, the air may not absorb more moisture than the additional capacity of absorption that would be obtained by heating it from an ambient temperature of −20 deg C to −10 deg C, which means approximately 1·25 gm/m³ of air. The blowing-in of approximately 600 m³/hr (21,000 ft³/hr) (13 changes) should ensure freedom from mist.

If the windows have double panes, the temperature of the inner face will be −2·5 deg C and this means that the fresh air can absorb approximately 3·5 gm/m³ before mist begins to form on the windows. So the amount of air theoretically required to keep the windows free of mist drops to approximately 215 m³/hr (5 changes). Naturally, no other part of the body may then have a higher heat transfer number than that for double pane windows, otherwise mist will begin to form on these parts instead of on the widows, and this would be even more unpleasant. It is evident that, if ventilation is limited, increasing the temperature of the panels by insulation is good from the point of view of freedom from mist. Even though the air quantity itself should be sufficient to guarantee freedom from mist, the heated fresh air should, so far as possible, be directed straight on the windows or near them to ensure that no mist forms on them.

For reasons of safety, windscreens and windows at the side of the driver's seat must be kept absolutely free of mist and ice both inside and outside. Therefore, sufficiently large quantities of heat must be conveyed to them so that even snow and ice on the outside is sure to melt. One method of doing this is to employ electric heating, but the most usual is to blow heated fresh air from a defroster unit on to the windows. A unit widely used in Sweden can be set to any one of three positions and has a maximum capacity of approximately 300 m³/hr (10,500 ft³/hr). Generally, only about half of this quantity is required, which means that the defroster can be assumed to be operated at an output of approximately 150 m³/hr, thereby contributing only 3½ changes of air per hour to the overall ventilation, so facilities for additional ventilation of the interior must be provided.

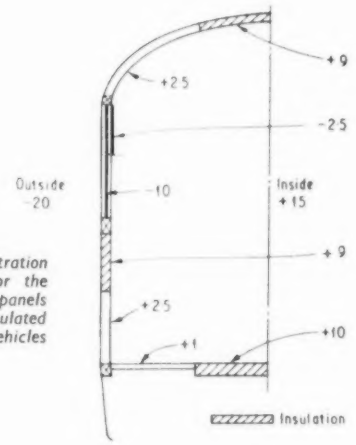
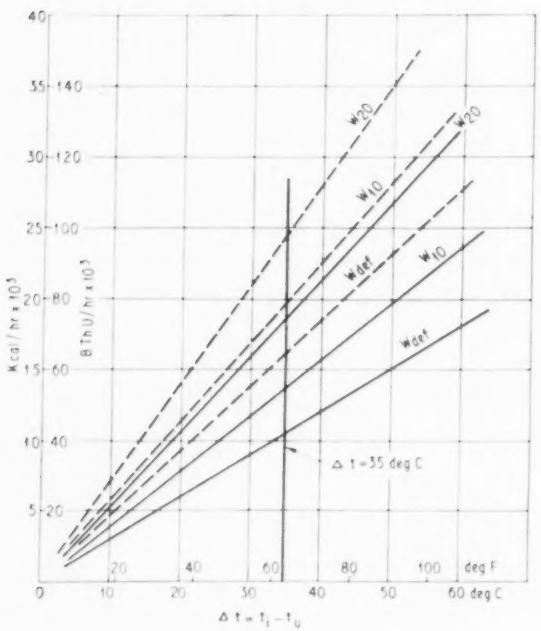


Fig. 2. Diagrammatic illustration giving typical figures for the temperatures of the inner panels of insulated and uninsulated single-deck public service vehicles

Fig. 3. Curves showing the total heat requirements for insulated and uninsulated bodies when the vehicle is in motion and the air is supplied at the rate of 4, 10 or 20 changes per hour. The requirements are specified as a function of the temperature difference $(t_i - t_u) = \Delta t$



In the following the heat W required for the ventilating air is calculated for three assumed conditions:

1. W_{def}, from the defroster unit alone, capacity 150 m³/hr (5,250 ft³/hr), 3½ changes/hr
2. W_{10}, from the defroster unit plus another source, capacity 450 m³/hr (16,000 ft³/hr), 10 changes/hr
3. W_{20}, from the defroster unit plus another source, capacity 900 m³/hr (31,500 ft³/hr), 20 changes/hr

Twenty changes of air per hour can be taken as a good ventilation standard.

For the condition where $\Delta t = 35$ deg C we obtain:

W_{def} = 1,600 kcal/hr (6,400 B.Th.U/hr)
W_{10} = 4,900 „ „ (19,600 „)
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The total heating requirement for a bus in motion is obtained by adding the transmission heat, in accordance with the previous calculation, increased by 40 per cent as an allowance for a vehicle in motion.

14,400 kcal/hr are to be added for a non-insulated body
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Variation of the heat requirements with $\triangle t$ is shown in Fig. 3.

Summer conditions

An article on ventilation can scarcely be complete if it does not contain anything about summer conditions. To obtain acceptable conditions in buses when the outdoor temperature is 25 deg C (77 deg F) or more, ventilation must be increased so that, inside the vehicle, air at head level moves at a speed of about 1 to 2 m/sec (3·3 to 6 ft/sec). To achieve this, however, at least 100 changes of air are required per hour; this can be effected by utilizing the relative air flow due to the motion of the bus, and taking in air through roof ventilators and open windows. The movement of the air provides a feeling of refreshing coolness even at temperatures exceeding 30 deg C (86 deg F). Summer ventilation by means of windows that can be opened and roof ventilators is also essential for avoiding a high rise of temperature when the buses are standing in the hot sunshine.

Paint Heating

AS IS well known, there are a number of advantages to heating paint before spraying it; these, and other relevant information, have been set out in a leaflet on this subject, which is available from The Aerograph-DeVilbiss Co. Ltd., 47 Holborn Viaduct, London, E.C.1. In this leaflet is a chart designed to enable individual firms to determine how to apply paint heating to the best advantage, having regard for the circumstances relative to their own particular set-up.

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One of the chief reasons for heating the paint is that its viscosity is reduced, without using thinners, to that suitable for spraying purposes. It is claimed that, with heated systems, a high percentage of solids is deposited on the article that is being sprayed and that the coverage for every gallon of paint used is better than when thinners are employed with cold spraying.

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Stress Analysis

FOLLOWING an exploratory meeting, on 1st March 1960, arranged by the Institute of Physics, a Joint British Committee for Stress Analysis has been set up in Great Britain. This Committee will represent the interests of Great Britain, in the field of stress analysis, at the periodic meetings of the Permanent Committee, which are held in Europe. Thus, it will ensure adequate British participation in international conferences in this field.

The principal object of the Permanent Committee, membership of which is open to all west European countries, is the furtherance of international collaboration in the field of stress analysis, and in seeking to achieve this end, international conferences will be arranged at four-year intervals. These conferences will normally be phased with the International Congresses on Applied Mechanics. The officials and secretariat of the Permanent Committe will normally be appointed by the National Committee in whose country the next international conference is due to be held.

The objectives of the Joint British Committee for Stress Analysis will be to act in the collective interest of the constituent bodies:

(a) by maintaining liaison with the Permanent Committee for European or International Conferences on Stress Analysis, and
(b) by maintaining liaison with overseas societies and institutions concerned with stress analysis.

The Joint British Committee consists of representatives appointed by The Royal Aeronautical Society, The Institution of Civil Engineers, The Institution of Electrical Engineers, The Institute of Marine Engineers, The Institution of Mechanical Engineers, The Royal Institution of Naval Architects, The Institute of Physics and the Physical Society, The Institution of Structural Engineers and the Institute of Welding. Mr. A. F. C. Brown, of the National Physical Laboratory, and the representative of the Institution of Mechanical Engineers, has been elected the first chairman of the committee, and The Institution of Mechanical Engineers provide the committee's secretariat.

PowerGrip Drives on B.R.M.

SINCE the publication, in the April issue of *Automobile Engineer*, of a brief article on PowerGrip belt drives, information has been received from the manufacturers, The North British Rubber Co. Ltd., regarding a further application of these drives. On the latest B.R.M. rear-engine racing cars, the two magnetos are driven by standard PowerGrip belting, of $\frac{3}{8}$ in pitch and $\frac{1}{2}$ in wide. The magnetos, which are of Lucas manufacture, are mounted in cradles, one on each side of the crankcase. Since the input shaft of each drive runs at half engine speed, by virtue of internal 2 : 1 gear reductions, the belt drives have a 1 : 1 ratio.

The pulleys have 20 teeth, giving a pitch-circle diameter of 2·387 in, and the driving pulley on each side is shrouded to prevent the belt running off. The centre distance between the pulleys of the right-hand drive is 6 in, whereas on the left it is $7\frac{1}{2}$ in, owing to the position of the fuel pump. Since the maximum crankshaft speed is in the region of 8,000 r.p.m, the corresponding linear speed of the belt is 2,500 ft/min, which is considerably faster than the 1,750 ft/min of the $\frac{1}{2}$ in pitch PowerGrip drive described in the issue mentioned earlier. It is understood from The North British Rubber Co. that the drives are proving entirely satisfactory in this unusually arduous application.

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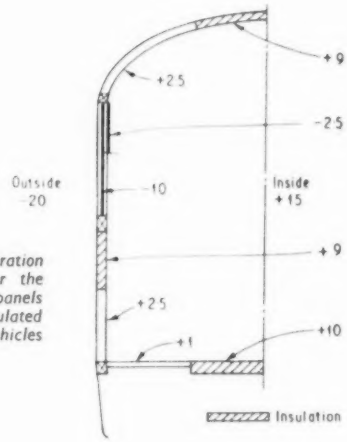
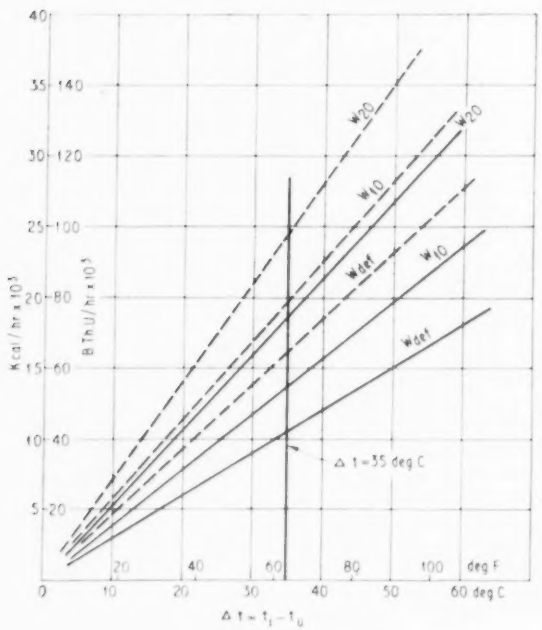


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Paint heated under pressure is prevented from boiling, but when it is released from the gun nozzle the solvents vaporize rapidly and assist in the atomization of the paint, so the risk of orange peel effects in the finish is obviated. Controlled flow-out is provided by the loss of mobility of the heated paint as it cools on the surface. As the temperature of paint is raised its viscosity becomes more stable, and therefore the operator is less likely to have to make frequent adjustments to the gun. It is also claimed that, because of the high percentage of solids deposited on the surface being sprayed, heated paint gives heavier coatings, better protection, higher gloss, less shrinkage, better adhesion and longer life; comparisons, of course, are based on equal volumes of paint sprayed from the gun in a given time. Because the solvents evaporate more readily when heated paint is used, drying times are reduced.

Stress Analysis

FOLLOWING an exploratory meeting, on 1st March 1960, arranged by the Institute of Physics, a Joint British Committee for Stress Analysis has been set up in Great Britain. This Committee will represent the interests of Great Britain, in the field of stress analysis, at the periodic meetings of the Permanent Committee, which are held in Europe. Thus, it will ensure adequate British participation in international conferences in this field.

The principal object of the Permanent Committee, membership of which is open to all west European countries, is the furtherance of international collaboration in the field of stress analysis, and in seeking to achieve this end, international conferences will be arranged at four-year intervals. These conferences will normally be phased with the International Congresses on Applied Mechanics. The officials and secretariat of the Permanent Committe will normally be appointed by the National Committee in whose country the next international conference is due to be held.

The objectives of the Joint British Committee for Stress Analysis will be to act in the collective interest of the constituent bodies:

(a) by maintaining liaison with the Permanent Committee for European or International Conferences on Stress Analysis, and
(b) by maintaining liaison with overseas societies and institutions concerned with stress analysis.

The Joint British Committee consists of representatives appointed by The Royal Aeronautical Society, The Institution of Civil Engineers, The Institution of Electrical Engineers, The Institute of Marine Engineers, The Institution of Mechanical Engineers, The Royal Institution of Naval Architects, The Institute of Physics and the Physical Society, The Institution of Structural Engineers and the Institute of Welding. Mr. A. F. C. Brown, of the National Physical Laboratory, and the representative of the Institution of Mechanical Engineers, has been elected the first chairman of the committee, and The Institution of Mechanical Engineers provide the committee's secretariat.

PowerGrip Drives on B.R.M.

SINCE the publication, in the April issue of *Automobile Engineer*, of a brief article on PowerGrip belt drives, information has been received from the manufacturers, The North British Rubber Co. Ltd., regarding a further application of these drives. On the latest B.R.M. rear-engine racing cars, the two magnetos are driven by standard PowerGrip belting, of $\frac{3}{8}$ in pitch and $\frac{1}{2}$ in wide. The magnetos, which are of Lucas manufacture, are mounted in cradles, one on each side of the crankcase. Since the input shaft of each drive runs at half engine speed, by virtue of internal 2 : 1 gear reductions, the belt drives have a 1 : 1 ratio.

The pulleys have 20 teeth, giving a pitch-circle diameter of 2·387 in, and the driving pulley on each side is shrouded to prevent the belt running off. The centre distance between the pulleys of the right-hand drive is 6 in, whereas on the left it is $7\frac{1}{2}$ in, owing to the position of the fuel pump. Since the maximum crankshaft speed is in the region of 8,000 r.p.m, the corresponding linear speed of the belt is 2,500 ft/min, which is considerably faster than the 1,750 ft/min of the $\frac{1}{2}$ in pitch PowerGrip drive described in the issue mentioned earlier. It is understood from The North British Rubber Co. that the drives are proving entirely satisfactory in this unusually arduous application.

Automatic Bus Conductor

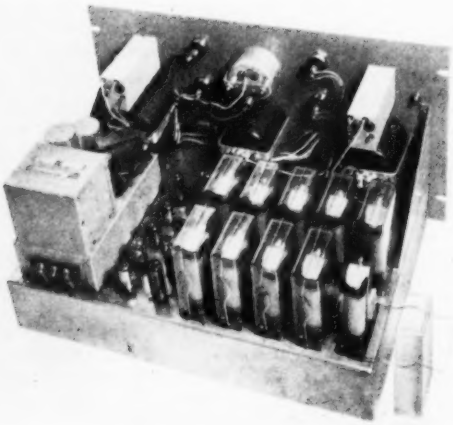
An Automatic, Start-Stop Indicator Developed for Use in Road Testing Public Service Vehicle Brakes

A. D. M. FROOD*

AMONG the essential phases in the development and production of a brake lining is its road test, which of course must be carried out under conditions similar to those that will be met in service. With linings intended for use in public service vehicles this presents special problems, since to simulate actual service, a test bus running in normal suburban or city traffic must stop at intervals corresponding to bus stops, and remain stationary for a period corresponding to the mean time taken to let down and take up passengers. Since it is undesirable to tax the driver with the additional task of time-keeping, the instrument to be described was developed for this purpose. Its function is to signal to the driver by means of the buzzer, exactly as in normal operation.

Fig. 1. Of the two illustrations below, which are of the condenser charge type cycle timer, the upper one shows the instrument panel and the lower one the interior, with one of the ten plastics covers removed





In the case of a suburban bus service, the average between-stops cycle, taking no account of traffic effects, is just over one minute, consisting of some 45 seconds accelerating and free running, 6½ seconds standing and the remainder braking. Under the test conditions, the braking time is determined not by the instrument but by the action of the driver.

The instrument, Fig. 1, is basically a scale-of-two timer operating at alternate 45 and 6½ second intervals. Test vehicles to which the instrument is fitted run among normal traffic on ordinary suburban and country roads. Therefore, if the signal to stop has been given and this signal also starts a second timer simulating standing time, difficulties could arise even if mean decelerating time were to be added to standing time: the driver could easily find himself out of phase with the signal if, owing to traffic conditions, he could not begin braking immediately on receipt of the stop signal.

It is necessary, therefore, to delay the initiation of the second period of time, that is, for standing, until the vehicle has actually stopped. For this purpose, a signal indicating motion or no motion of the vehicle is passed to the instrument. This is done by relay D, Fig. 2, which operates on the principle of the use of the output from an electric tachometer on the gearbox output shaft, to bias a triode valve beyond the cut-off. Elapsed time indicators are provided, to sum separately the free running, braking and standing times. There are two counters, CA and NCA, which count separately the brake applications made in response to the stop signal and those made because of traffic conditions.

Operation of the instrument is based on two capacitor-charge type timers, each tripping the trigger of a Z.803U trigger tube with a relay in its anode circuit. The standing timer relay is indicated at A and the free running timer relay at B. These relays energize and de-energize the interlock C. There is also a brake interlock relay F, and a motion interlock relay D. The buzzer operating relay is shown at E; and G and H hold the brake application count until the pedal is released, so that when the stop signal is given, the count is registered as "cycle" or "non-cycle" according to whether or not the vehicle actually stops.

The action is as follows:

(1) The instrument is switched on some fifteen minutes before starting on a test run. During this time, D relay becomes energized owing to the triode's conducting, and the red lamp is illuminated; relay A operates and causes C to be energized and held. After relay D closes, the "standing time elapsed" indicator operates during the whole of the time the vehicle is stationary

(2) When the bus is driven away, relay D is de-energized owing to the tachometer output's biassing the triode beyond cut-off. The free running time indicator starts

* *Research Division, Ferodo Limited, Chapel-en-le-Frith, Stockport.*

and the standing time indicator stops. Simultaneously, the timer B is initiated, and also the green lamp is illuminated

(3) After 45 seconds, relay B operates, rings the buzzer once and de-energizes C. As the traffic conditions permit, the driver brakes; this energizes relay F, which puts the braking time indicator in operation and stops the free running time indicator. At the same time, the orange lamp lights

(4) The bus stops at a deceleration controlled by the driver. Relay D becomes energized, the braking time indicator stops, the standing time indicator starts, and the red lamp lights. As the brake pedal is released; the counter CA registers one count, but will not operate again on application of the brake pedal whilst the vehicle is stationary; and the operation of the timer A is initiated

(5) After 6½ seconds, relay A operates and energizes C, which holds; the buzzer is operated twice, in quick succession, and the cycle is complete.

Should the driver brake during the 45 second period, whether to a standstill or not, the blue lamp lights during the application and the counter NCA registers one count when the brakes are released. If, owing to traffic or for any other reason, he brakes after the stop signal but does not come to rest, this application will also be registered on the NCA counter. The first brake application to rest after the signal has been given will be registered as the cycle application, and will initiate operation of the A timer.

To obtain a signal at the instant the bus moves, it is necessary for the bias voltage to rise quickly, and so the tachometer used is a rotary transformer, the output of which is some 300 V at 30 m.p.h. To prevent damage to the triode during reversing, a rectifier is incorporated, and to limit the maximum voltage, a voltage stabilizer is placed across the tachometer output. This arrangement operates satisfactorily under all conditions the bus meets under operation in normal service.

Another facility provided by the timer is the provision of a "fast cycle". This allows for 30 seconds free running but, owing to limitations in respect of the type of bus in use and the fact that it is fully loaded at all times, the vehicle is incapable of attaining 30 m.p.h. from rest in this time, so the brake applications on this cycle are maintained by the driver down to 10 m.p.h. only. He then receives the restart signal. The interlock for this facility is the relay J, energized by a transistor photocell in the vehicle's speedometer, which is so arranged that the light to the photocell is cut off when the indicator is registering at 10 m.p.h. or less.

In Fig. 1 can be seen the two counters, three elapsed time indicators, the on-off and facilities, switches and a clock. Behind the panel bearing the label, on the front of the instrument box, are three coarse and three fine timer-controls: one pair for standing time, and two pairs for free running time, one on each of the two cycles. There is also a switch for setting the counters to zero, and a switch that breaks the triode anode circuit, to simulate motion, for setting-up purposes.

The H.T. supply to the timing tubes is stabilized, and the capacitor charging voltage is obtained by voltage reference tubes. Further, the 12 V supply is taken from a 12 V accumulator, which is floating at a 5 amp charge rate on the 24 V vehicle supply. Good time stability is thus obtained at an accuracy greater than that to which the driver can work, even under the most favourable conditions.

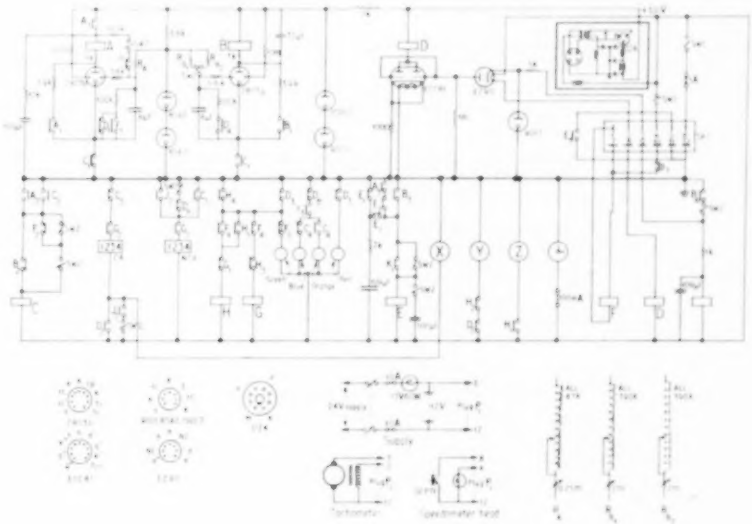


Fig. 2. This diagram shows the arrangement of the electronic circuit of the cycle timer. The pins 5 and 11 on P_1 are connected across the push-button switch for the buzzer, pins 1 and 7 across the red lamp, and pins 1 and 10 to the orange lamp

CA *Counter totalling brake applications to rest, made in response to the stop signal;* **NCA** *Counter totalling all other brake applications;* **X** *Time integrator totalling the time the vehicle is at rest;* **Y** *Time integrator totalling free running time;* **Z** *Time integrator totalling braking time*

Autocar's Show Numbers

THIS year, the three London Show Numbers of our associated journal, *The Autocar*, will again be much larger than the regular issues, to ensure complete coverage of this major event. As in previous years, the Show Guide, to be published on 14th October, price 1s, will be comprehensive, with stand plans, lists of exhibitors, advance news of the car, caravan, engine and accessory exhibits, and buyer's guide tables. In addition, there will be two big bonus attractions: they are the eagerly awaited list of prizewinners in *The Autocar's* unprecedented £7,500 Free Car Competition and a full-scale report of the Paris motor show.

The Show Report, which will be published on 21st October, price 2s 6d, will be three times the normal size. It will feature new models, announced at the last minute, and a stand-to-stand review of the show, with detailed descriptions of exhibits. There will also be a full complement of regular features and supporting articles. Finally, The Show Review will appear on 28th October, price 1s. This number will feature expert views and comment on many of the exhibits in all of the sections at Earls Court. It will also contain an end-of-show survey of design trends, a road test report of a new car, and special supporting features.

New Plant and Tools

Recent Developments in Production Equipment

AN undercrank machine fabricated from steel plate and capable of cutting mild steel up to 8 ft wide by $\frac{1}{4}$ in thick is the latest addition to the range of guillotines built by F. J. Edwards Ltd, Euston Road, London, N.W.1. Baseplate, bed, and side frames are welded up into one unit and the top bridge and the cutting beam are each of heavy box-type construction. A feature of the crankshaft design is the multiple bearing arrangement mounted below the bed; motion being transmitted to the cutting beam by cast steel connecting rods. Beam slides are fitted with plastics wear strips, ensuring a low frictional coefficient and obviating the need for lubrication. Adjustment for wear is provided by gib strips, and blade clearance is set by the screw adjustment of the blade block.

Drive is by a high-slip, 10 h.p, 3,000 rev/min, 3-phase motor through a worm gear, with an electrically operated clutch and an electromagnetic brake mounted on the worm shaft. Control is by a remote, freely-sited foot switch. The machine is designed for either single or continuous stroking and selection is effected by a conveniently mounted switch. On single stroke, a cam-operated limit switch stops the machine automatically at the top of the stroke; on continuous stroking the rate is 35 strokes/min. All elements of the drive are enclosed and there are no externel moving parts.

Equipment includes a power-operated, precision, back gauge with a large-scale, front-view indicator calibrated to 0·005 in. Control is by switch at the front of the machine, giving a fast traverse and a slow approach speed to facilitate accurate setting. The range is 24 in and limit switches at each end prevent inadvertent overrun. An adjustable front gauge, extending to 30 in, and a side-squaring gauge are also provided. The automatic hold-down arrangement comprises a number of plungers individually loaded by multiple disc springs. Electrical controls, grouped in a panel on the side of the machine, include an overload protection device, and a light to indicate the motor is running. A common isolator switch is fitted in accordance with safety regulations.

Air line lubricator

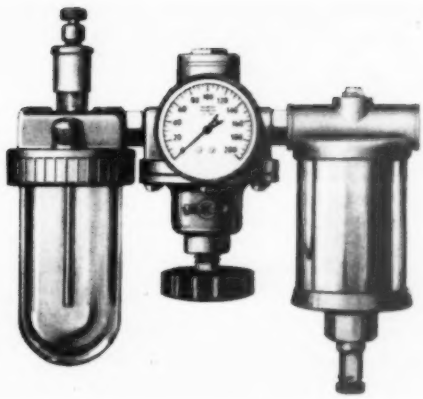
With the object of ensuring clean and controlled air line lubrication to reduce maintenance and prolong the service life of air-powered motors, tools, actuating cylinders, valves, and other equipment, B.E.N. Patents Ltd., a division of Broom and Wade Ltd., High Wycombe, Buckinghamshire, have developed the Controlube unit. A complete unit embodies three standardized components:

1. A moisture separator for the efficient removal of condensed water and other impurities from the compressed-air line. It is fitted with a replaceable filter and is supplied complete with a drain cock.
2. A pressure-reducing valve complete with gauge for use where it is necessary to reduce the main line air pressure for different services. This component automatically adjusts pressure on the outlet side to the pre-set figure on the dial of the pressure gauge. The diaphragm is of Neoprene to ensure long life.
3. A replaceable-bowl lubricator to provide lubrication for all types of pneumatic tools by means of a regulated airborne oil fog. The oil flow is automatic and the feed is clearly visible through the sight glass. Rate of oil feed is easily and accurately adjusted by the screw at the top of the lubricator. Refilling can be effected without closing air flow.

For air line systems where a pressure-reducing valve or other form of pressure control is already installed, the Controlube Minor unit which comprises a moisture separator



Besco-Truecut undercrank guillotine. Capacity, 8 ft wide × $\frac{1}{4}$ in thick
(F. J. Edwards Ltd.)



B.E.N. "Controlube" air line lubricator
(B.E.N. Patents Ltd.)



Kerry's bench-mounted ultrasonic cleaning units
(Kerry's (Ultrasonics) Ltd.)

and a lubricator only can be supplied. Both units are available for $\frac{1}{4}$ in and $\frac{3}{8}$ in B.S.P. line connections.

Ultrasonic cleaning equipment

A range of three small ultrasonic units for cleaning small components or assemblies, such as ball or roller bearings, instrument movements, hydraulic control valves, or optical items is now produced by Kerry's (Ultrasonics) Ltd., Wharton Road, Stratford, London, E.15. The units operate at a frequency of 40 Kc/s, with the barium titanate transducer bonded directly to the base of the stainless steel cylindrical container. Dimensions of the containers are $2\frac{1}{4}$ in diameter $\times 4\frac{1}{2}$ in, $4\frac{1}{2}$ in diameter $\times 6$ in, and 5 in diameter $\times 5$ in, with respective capacities of 0·7, 1·0, and 2·0 litre. Each container is mounted on a plinth, enabling it to be stood on the bench or positioned on a conventional cyclic cleaning machine to take part in a cleaning sequence including pre-washing, rinsing, and drying.

All units are energized from a Mullard 250 W ultrasonic generator, type L 325, measuring overall 12 in $\times$ 10 in $\times$ 9 in high and weighing approximately 42 lb. By means of a selector switch assembly, a number of cleaning units can be energized consecutively from a single generator. Any of the normal range of cleaning agents can be used, including chlorinated solvents, organic solvents, water solutions, or mild acids. A solvent filtration unit for the continuous removal of solids down to approximately one micron particle size can be supplied. Also available is a small bench-mounted vapour still for use with trichlorethylene or perchlorethylene as a component — drying or solvent — recovery apparatus.

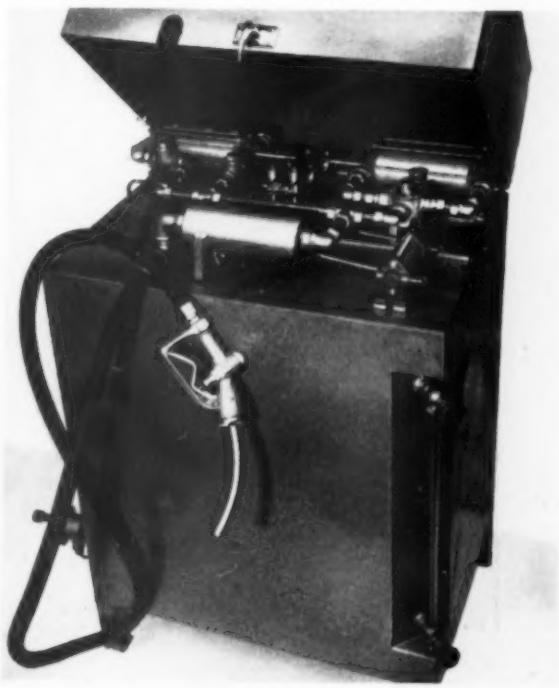
Liquids blending machine

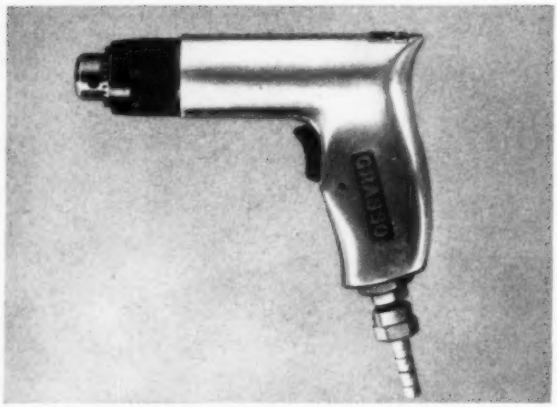
Designed to effect an intimate mix of two or more liquids in a pre-set proportion immediately prior to delivery, the blending machines produced by Suba Hydraulics Ltd, 86 Lind Road, Sutton, Surrey, obviate the problems of inconsistency, settling out, and wastage commonly associated with either small or bulk batch blending. The original model, illustrated, was specially produced for the Ford Motor Co. Ltd. to expedite the filling of engine coolant systems with a mixture of water and anti-freeze solution. It is normally set for a mix of 75 per cent water and 25 per cent anti-freeze but its range, set by micro-adjustment, is for mixtures of 67-33 per cent to 84-16 per cent.

In the unit illustrated, mains water pressure at 25 lb/in^2 is used to energize the double-acting water cylinder which in turn drives the other double-acting liquid cylinder or cylinders. For other blends a different liquid under pressure could be used or, if desired, air pressure. The unit is interlocked through each liquid to stop operation should the operator allow the supply of any liquid to fail. Stroke reversal is effected by means of a changeover valve in the mains water supply line, operated by a small, compressed air actuation cylinder controlled by an air valve coupled to the main cylinder linkage. Air supply is float-controlled from the anti-freeze service tank housed in the machine pedestal. No electrical controls are required. At a mains pressure of 25 lb/in^2 the maximum delivery is 10 gal/min; at 120 strokes/min the output is 5 gal/min.

All liquid cylinders are of brass; end covers, pistons and valves of bronze, and pipes and fittings of copper and galvanized steel. Stainless steel can be used if required for

Suba blending machine for charging engine coolant systems
(Suba Hydraulics Ltd.)





Morrisflex-Grasso B.12 series silent pneumatic hand drills
(B. O. Morris Ltd.

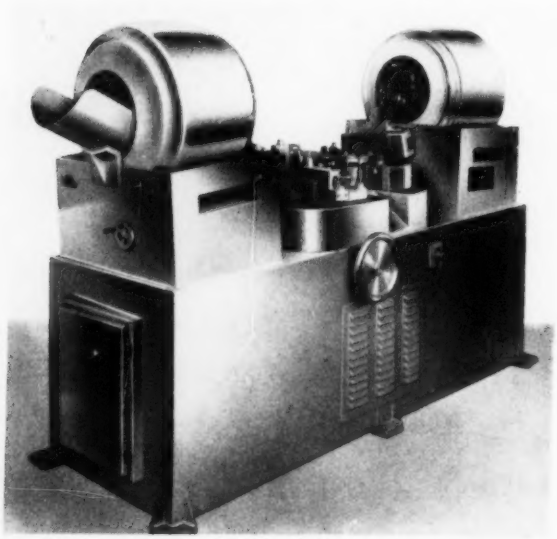
all components in contact with the liquid being handled. Machines can be adapted for paint spraying and similar finishing work. They are also used for paint mixing and colour blending.

Planetary thread-rolling machines

By employing an annular die rotating at a constant speed inside two diametrically opposite stationary dies, the planetary principle advances the thread-rolling method from intermittent, reciprocating cycling to continuous cycling. These American-built machines are capable of high rates of output since, according to the type and dimensions of the part, from 12 to 16 parts can be rolled in one revolution of the die. The Model 125 A illustrated, for example, can handle screws of from 6 B.A. to $\frac{5}{16}$ in diameter up to 3 in long at production rates of from 400 to 800 pieces/min.

Work is fed by two hoppers and adjustable, vibratory feed rails. Spring-loaded, cam-operated feed fingers are interchangeable for different work diameters. By reason of the length of the die surface—the rotary die is approximately 12 in diameter—its useful life is relatively long. Commonly it is good for up to 5 million pieces before requiring renewal.

High-output, planetary, thread-rolling machine
(Funditor Ltd.)



Selling agents are Funditor Ltd, 3 Woodbridge Street, London, E.C.1, who handle the range of these machines.

Slow-speed pneumatic drills

A range of Grasso pneumatic drills, manufactured in Holland, has recently been introduced by B. O. Morris Ltd, Briton Road, Coventry. These tools are small, light, and of a smooth, convenient shape with a piston-grip handle. A feature is their quiet operation; a matter of some importance in shops where numbers of air-powered tools are in use.

Standard models, B.12/30 and B.12/41, both have $\frac{1}{4}$ in. diameter chucks and run at 3,000 rev/min and 4,100 rev/min respectively. Additionally, there is a range of four slow-speed models in the same series. These are equipped with $\frac{1}{16}$ in diameter chucks and designed for operation at 400, 600, 800 and 1,000 rev/min. They are intended for use in the fabrication of stainless steel and other materials relatively difficult to machine.

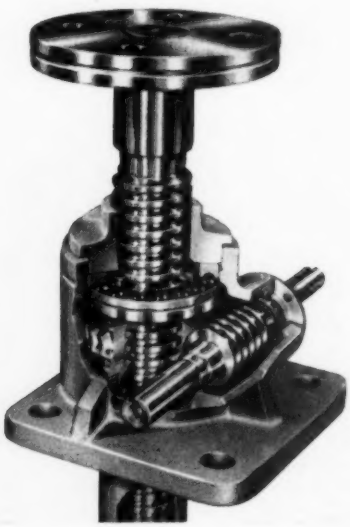
Worm-geared jacks and actuators

Specifically designed for building into machines and equipment where jacking or linear actuation operations are required, these worm-geared, mechanical jacks are self-locking and can hold very heavy loads in position indefinitely without risk of creeping. Introduced by the Consolidated Pneumatic Tool Co. Ltd, Dawes Road, London, S.W.6, and designated the Duff Norton 1800 series, the range consists of eight units having capacities of from two to 100 tons.

Features common to all models include the use of heat-treated, phosphor-bronze, worm-wheel teeth and the absence of keying in the lifting screw. The head of the lift screw is flanged and bolted to the member being actuated, thus preventing it from turning. When closed, the heights of the units range, from smallest to largest, $5\frac{1}{4}$ in to 24 in, and while standard lifts are up to 24 in, greater lifts can be supplied on demand.

Unit weight, based on a 6 in lift, is from 17 lb to 1,200 lb. They can be used as linear actuators to pull or push, or to apply pressure in any direction. Arranged in any combination connected through shafting and mitre gearboxes, and operated from a common power source, they will lift at a uniform rate and sustain unevenly distributed loads.

Duff Norton worm-geared jacks
(Consolidated Pneumatic Tool Co. Ltd.)



Production of Reinforced Plastics Panels

New Techniques in Laying-up Motor Vehicle Body Panels Reduce Production Times and Costs, Making Medium-scale, Continuous Output Economically Advantageous

In the belief that body panels of reinforced plastics are economic only where small-scale production is involved, the motor industry in general has been slow to adopt the new materials. There would appear to be no immediate prospect of developments in the technique of lay-up moulding that would make reinforced plastics competitive with sheet metal for the full-scale mass production of bodywork as practised by the larger motor manufacturing companies. Advances in both methods and materials that have been made to date, however, enable firms building sports and other special bodies, and also those engaged in the conversion of certain vehicles, to maintain a continuous production of plastics panels and components on a not inconsiderable scale.

By careful choice of materials, selection of the most efficient moulding techniques, and adequate planning of operations, the economic advantages secured are worthwhile. Heavy expenditure on presses and on press tooling are avoided, and there need be little delay before production can be started. The simplicity of the equipment required, and the relative ease with which mould forms can be produced, reproduced, or modified, confers a flexibility in production that is unrivalled by any other method. This facility is of particular value to firms building bodies or executing conversions on vehicles produced by several different manufacturers. Obviously, the most significant advantage is to be gained on the larger components—roof panels in particular—for which the cost and the time required for tooling would, in such applications, be prohibitive.

An example is provided at the Folkestone works of Martin Walter Ltd, where caravan conversions of standard light commercial vehicles are carried out. Full advantage is taken of the properties of reinforced plastics, from both production and utilitarian viewpoints.

Some of the Martin Walter "Dormobile" conversions are illustrated in Fig. 1. These vehicles have an elevating roof and according to the interior design, provide day and night accommodation for from two to five occupants, which compares well with that of a towed caravan. Plastics construction has certain obvious advantages for the redesigned roof. It is extremely light, easy to mould to the complex double curvature required to blend with the roof line of the basic van, completely unaffected by weather, and easy to repair if damaged. Small modifications in design, arising from time to time in the light of experience, are more easily incorporated in this form of construction than in any other. A final important feature is the translucency of the roof, which is achieved over the whole surface, making the interior of the body comfortably light and of airy appearance.

High-quality tools

Although very simple tools, made of wood and plaster, can be used quite satisfactorily to turn out a few mouldings by hand, the trouble and expense of making high-quality tools is more than justified where large quantities are likely to be required. The aluminium tool shown in Fig. 2 is an instance of this. Originally made in 1951 to produce the first Dormobile ever built, it is still a valuable asset. Although no longer used as a production mould, it forms the basis of

Fig. 1. Some of the caravan conversions by Martin Walter Ltd. Roof mouldings are characterized by light weight, high strength, and translucency



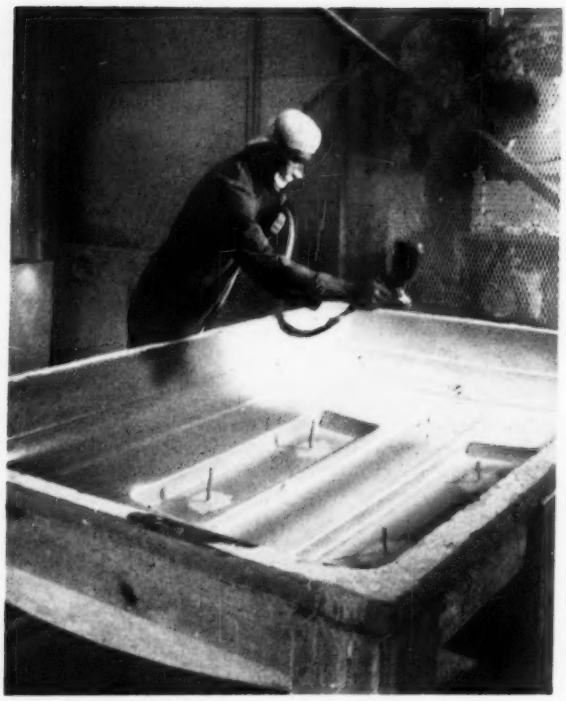


Fig. 3. To obtain even translucency, the first gel coat is applied by spray

every new mould designed to match different makers' chassis.

When a new design is produced, a reinforced plastics pattern is laid up in the aluminium mould, then modified by cutting and filling with wood and plaster to produce longer or shorter, wider or narrower, deeper or shallower profiles. From this pattern, a very stout master mould is made in which a heavy production pattern is laid up. This is used to produce a series of production moulds from which the production roofs are made. Although this seems a somewhat complicated way of reaching a simple end, it means that, for long production runs, new moulds can be made whenever required from a perfect pattern which is used relatively few times. For shorter runs, and for minor modifications, a new pattern may be cast on a production mould, to save storing a bulky and expensive master pattern.

The life of a production mould averages between 500 and 1,000 production mouldings. This unusually high figure is largely due to the great care that is taken to clean the surface between moulding cycles. Instead of the fairly common practice of applying only a fresh layer of release agent, the mould is invariably washed, rinsed, very thoroughly waxed, and treated with polyvinyl alcohol release agent after every cycle. This greatly reduces the danger of pick-up, which is the normal limiting factor in mould life.

Sprayed gel coat

Since the mould surface itself sets the standard for the moulding finish, it is normal practice in most moulding shops to apply the gel coat, which prevents penetration of the glass fibres to the outer surface, with a heavy brush. The brushed internal finish is normally regarded as of no consequence, since this becomes an integral part of the moulding. At Folkestone, however, it is considered most important to maintain an even translucency over the entire surface, which could not be obtained with the uneven distribution of pigments inevitable with brush application. The white-pigmented gel coat, therefore, is sprayed on in the special, exhausted booth shown in Fig. 3. This operation calls for considerable skill to maintain just sufficient density to obscure the texture of the chopped-strand glass mat used in laminating, without unduly obstructing the passage of light. The metal rods mounted with adhesive tape in the recesses in the centre of the mould are intended to provide entry holes for the jigsaw later used to cut out the rooflight apertures.

Lay-up

The glass mat is applied in the usual way, using brushes and ribbed rollers to work the resin well into the glass, which has a weight of 1·5 oz/ft^2. The resin, one of a series produced by Artrite Resins Ltd, of 46 Kingsway, London, W.C.2, is a polyester-based compound, formulated to combine maximum strength with efficient bonding to glass and the gel coat. It is specially designed for applications

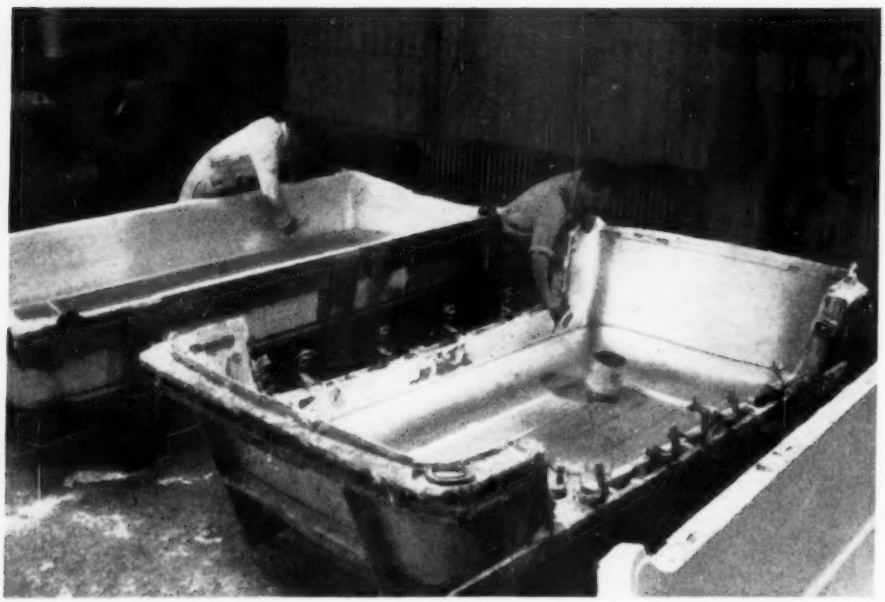


Fig. 2. The original aluminium mould (centre) for the first Dormobile is still used as the basis for new moulds incorporating modifications for a variety of conversion designs and to match the bodies of different chassis



Fig. 4. Applying a thin glass tissue to impart a smooth interior finish

where translucency is of importance. As regards fire hazard, the resin is positively self-extinguishing, an important characteristic in a caravan provided with cooking facilities.

This company also produces a range of resins specially compounded for the recently developed spray-moulding technique, that is shortly to be adopted by Martin Walter, Ltd. For this purpose a special three-nozzle gun has been developed, which applies resin and chopped-glass strand reinforcement simultaneously. The glass, supplied in the form of continuous roving, is chopped into short lengths and distributed by one nozzle, while the other two nozzles spray resin plus accelerator and resin plus hardener respectively. This system gives a very rapid and uniform coverage of the mould, and has the advantage that hardener, accelerator and resin do not come together until immediately prior to application. Thus, it avoids the wastage of materials that follows if more is prepared by conventional methods than is immediately required.

In Fig. 4 is shown the last layer of glass being applied to the moulding. It consists of a very fine glass tissue which imparts an attractive matt finish to the interior of the roof, and masks the coarser texture of the reinforcing mat. It also serves to locate moulded-in timber stringers, one of which can be seen at the right of the picture, on which interior fittings are later mounted.

Curing

Although the hardeners and accelerators incorporated in the resins will ensure complete curing at room temperature, the process can be considerably accelerated by the application of moderate heat. Apart from ensuring a quicker turn-round of tools and better use of floor area, heat-curing ensures the development of maximum physical properties in the moulding, and allows the content of hardener to be reduced. This, in turn, makes the time available for laying-up less critical, and obviates the danger of the resin beginning to set before consolidation is completed.

As soon as it is laid-up, a moulding is transferred to a steam-heated curing room, where it is held at 120 deg F for from 30 to 45 minutes. Time saved in curing is sufficient in this case to allow two mouldings to be produced in one day from each mould. The consequent savings have more than recovered the cost of the curing room. Moulds are mounted on wheeled trolleys. These have been found of great advantage, not solely for transfer to the curing rooms but also to provide general mobility and to enable the best use to be made of floor space available at any time.

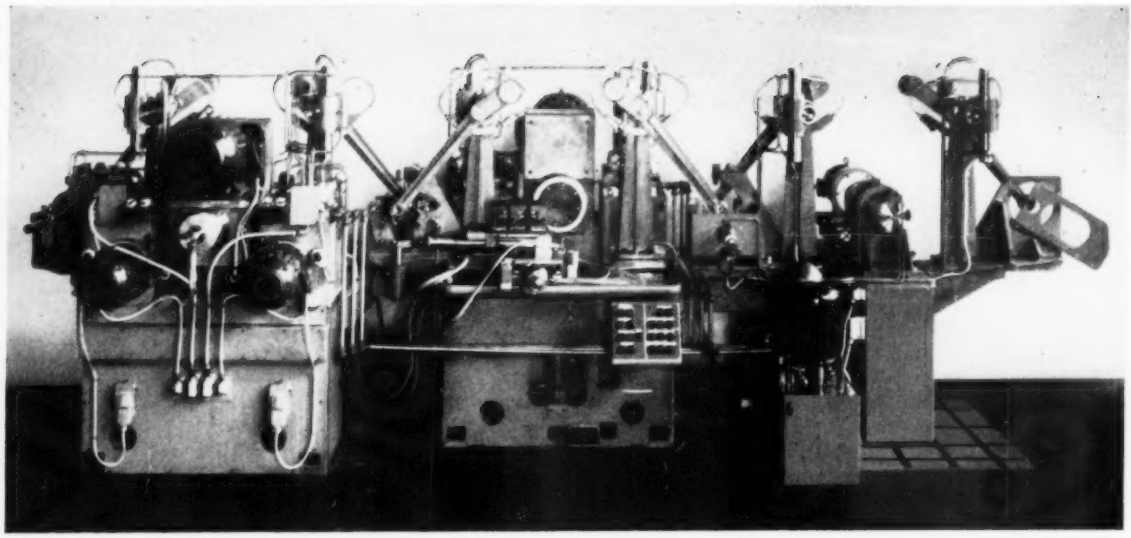
Assembly

The final stage in the production of the caravan roof is illustrated in Fig. 5. In this department, Perspex rooflights are fitted into moulded rubber sealing strips, and the hinges and fittings for the large, opening rooflight are added. The aluminium curtain rails on each side of the rooflights are screwed to the timber inserts which, as already mentioned, are securely embedded in the moulding. The operator is fixing the outer rail to which the plastics canopy will be fitted. This structure, which opens automatically when the roof is raised, can be seen in position in Fig. 1.

That the self-propelled caravan is rapidly increasing in popularity is shown by the number of manufacturers offering chassis for this purpose and the number of different firms carrying out conversions. The success of these vehicles, particularly of those involving major structural alterations, is due almost entirely to the development of reinforced plastics techniques. These offer, for the first time, a means of producing components of a size and complexity that hitherto could be justified in sheet metal only by very long production runs. On a broader front, through the production of special bodies, station-wagon conversions and other individual designs, plastics are helping to bridge the gap between the highly standardized designs inseparable from mass production techniques, and the increasing demand for a wider choice in body styles of greater individuality.

Fig. 5. Adding the canopy frame. Curtain rails are screwed to timber inserts





Müller fully automatic production line for machining wheel brake discs. Cycle time is 1·3 minutes

Machining Brake Discs

An Automatic Production Line Incorporating Specially Adapted Müller Front-turning Machines

As vehicle design progresses, a change in the basic type of particular components may be involved and this, in turn, may make it desirable to employ a different type of machine tool for the production of such components. The change from drum-type to disc-type wheel brakes is a case in point. In this, the critical element in machining is moved from boring to surfacing and an obvious selection for such work is the front-turning machine.

This type of chucking machine, fairly common in small sizes for fine-turning and fine-boring, is now becoming more widely used for the rapid machining of castings, forgings, and sawn blanks. When equipped with automatic feed and automatic chucking devices they are capable of rapid and continuous production, and pre-set tooling and programme control make changeover and setting easy and quick and minimize down time for tool changes. The availability of such fully developed machines is an example of the manner in which manufacturers of machine tools frequently anticipate the future requirements of industry.

The eighty-year-old firm of Max Müller Brinker Maschinenfabrik, of Hanover, Germany, have concentrated their efforts during the past four years on the development of programme-controlled, automatic turning machines. These are of the front-turning type specifically for machining flat or shallow parts of "less depth than diameter". They are equipped with electrical operating elements such as magnetic clutches, solenoid air or hydraulic valves, and relays, and controlled by limit switches of a special design having a switching time as short as 0·02 sec.

Cam plates on machine elements actuate the limit switches, giving impulses to the automatic programme-control system which, in turn issues commands for changes of feeds, speeds, or motions. The firm's automatic programme control system, designated the "Eltropilot", includes a locked plug-board and established programmes can rapidly be re-set by means of an overlying punched card. With the aid of pre-set, multiple tool blocks, set-up times have been reduced, in some instances, to 30–45 min; that is less for a controlled-programme, automatic-cycle machine than for a traditional universal machine. These machines, equipped with the Eltropilot programme-control system, were briefly described in an article* on the production of Smiths automatic transmission. For those units they are used to machine a number of rotating and stationary elements constituting the dry-particle magnetic couplings which are the characteristic feature of the transmission.

Recently, the Müller firm have built two fully automatic production lines for machining brake discs. Each line consists of three machines, two for turning and one for drilling operations. The two turning machines are basically Müller FD 500 front-turning lathes which, for this purpose, are stripped down to essentials for single-purpose instead of general-purpose operation. All elements not needed for this specific duty have been omitted from the machines. They have only one hydraulically operated, compound, tool slide and no gear mechanism for changing spindle speeds under load, since only one spindle speed is required. The Eltropilot universal programme-control system has also been dispensed with, as the relatively simple machining programme can be controlled by a fixed, permanent system.

The third machine is a four-spindle drilling unit. This, also, consists of standard units as used on the FD lathes. A hydraulically operated feed unit with a geared, motor-driven spindle is mounted on a base and fitted with a multi-spindle drilling head. By this judicious use of simplified, but basically standard, fully developed machines, so much time was saved in designing and building the specialized

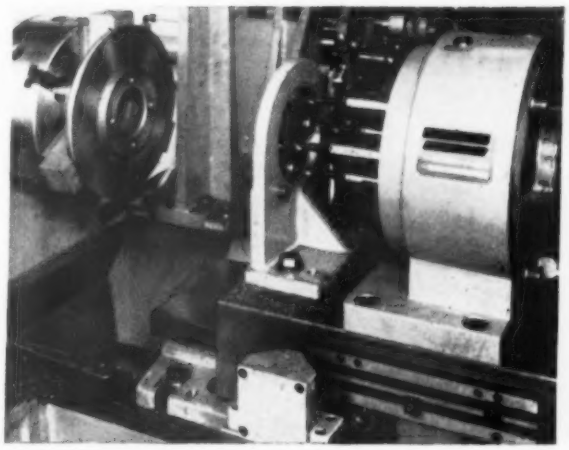
* "*Automobile Engineer*", *May*, 1960

production lines that they were completed and delivered long ahead of schedule.

To economize in floor space and to avoid the necessity of turning the workpiece through 180 deg during transfer, the machines are arranged alternately on each side of the flow line. In the illustration at the head of this article, the rear of the first machine, on the near side of the flow line, is on the left and the front of the second machine, located on the far side, is shown centrally. On the extreme right, beyond the drilling machine on the near side, is the unloading device and the inclined delivery slide. At the beginning of the line, and between first and second, and second and third machines are transversely arranged component magazines holding about 15 pieces. These provide buffer storage and enable the line to maintain production for a limited period, sufficient to permit tool-changing on one machine. Not shown is the free-standing electrical control cabinet.

Components are of cast iron, approximately 215 mm diameter, and dished at the centre. Viewing the line as illustrated, they travel from left to right, being loaded into the first magazine either manually or by any suitable feeding arrangement. At the first station, the disc is rough and finish bored, the bore is chamfered on the protruding face, surfaces in two planes are machined, and approximately half the width of the outside diameter is turned. At the second station, two faces in different planes are surfaced and the remaining half of the outside diameter is turned. On the third machine, the four stud holes are drilled in the offset hub portion.

What is possibly the outstanding feature of the line is the automatic loading, unloading, and transfer system. Each machine is furnished with two support pillars, each carrying a pivoted lever arm—one for loading and one for unloading. The levers are swung in a vertical plane parallel to the flow line, their free ends moving from magazine to chuck and from chuck to the next magazine respectively. A variation occurs at the third machine where the unloading arm moves to a stripping device which lifts off the workpiece for delivery down a slide. Work-gripping devices on the ends of the levers are virtually internal chucking members having



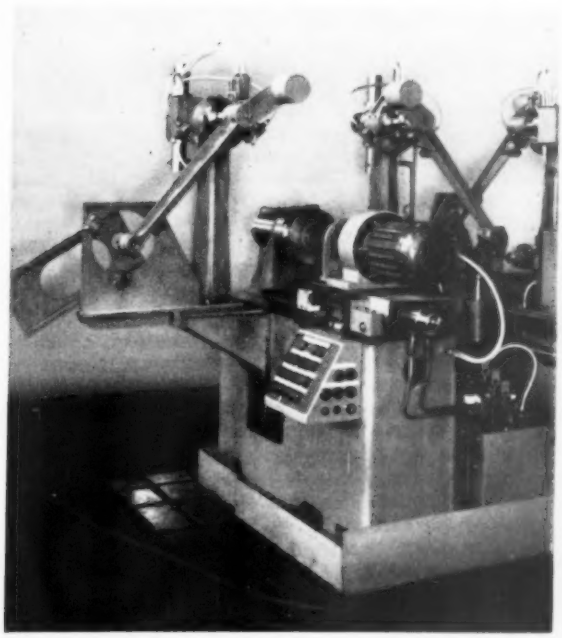
The four-spindle drilling machine at the third station

three spring-loaded jaws which are engaged in the bore of the component.

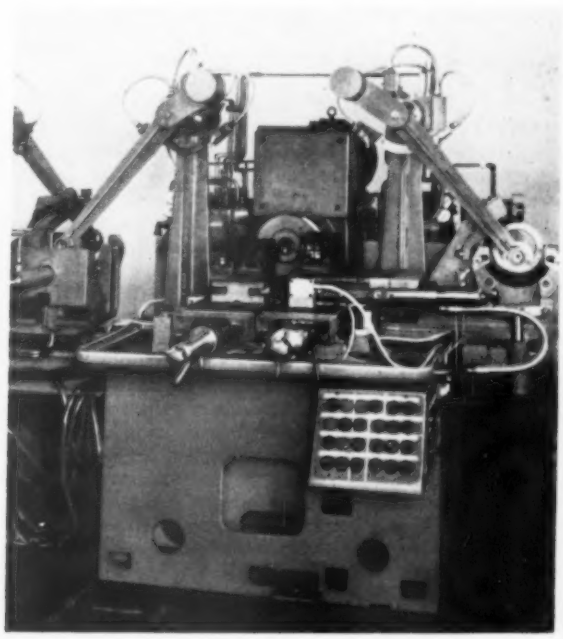
Both angular and axial movements of the lever arm pivot spindle are provided. Angular movement is by a vertically mounted hydraulic cylinder which partially rotates the spindle through a rack and pinion gear. Axially, the spindle is displaced by a further, horizontally mounted hydraulic cylinder in a direction transverse to the flow line. Both movements are precisely controlled by limit switches.

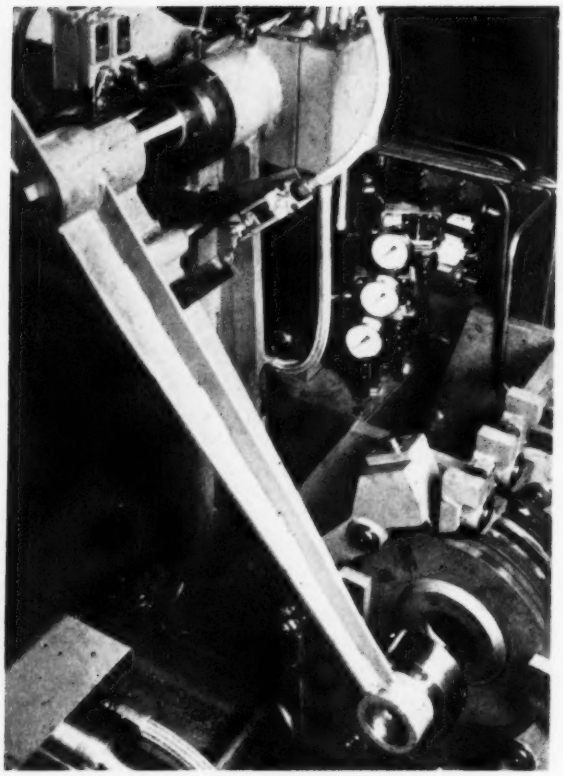
Starting with the first magazine loaded with components and the gripping device on the end of the loading lever arm aligned with the work stack, the lever spindle moves axially to engage the foremost casting. At the same time, a horizontal hydraulic cylinder on the magazine thrusts the stack forward and forces the foremost one over the sprung jaws of the gripping device. A circular plate on the end of the lever maintains the casting in a vertical position. Both

Rear view of drilling machine and final delivery slide



First front-turning machine, with loading and unloading devices





Arrangement of transfer arm, 3-jaw pick-up, and magazine

cylinders retract and simultaneously a vertical hydraulic cylinder on the magazine raises support arms to hold up the stack of parts.

Then the lever arm swings the workpiece across to align with the machine spindle and moves it axially into the shallow jaws of the hydraulically actuated chuck. Reversal of the axial movement of the lever pivot spindle draws the gripping device from the chucked work and the lever then swings back into line with the magazine ready for the next operation.

After the automatic machine cycle has been completed and the tool slide has retracted, the unloading arm swings into position, moves axially to force the gripping device into the workpiece, the chuck opens, and the work is withdrawn. The lever then carries the component into line with the second magazine. Here a U-shaped member actuated by a hydraulic cylinder strips it from the gripping device into the magazine and pushes it to the end of the stack of parts.

From the other end of the magazine, a part is picked off the stack by the loading lever of the second machine and transferred to the chuck. In this instance, since it has to be held with a very shallow grip on less than half the thickness of the disc, a Ringspan chuck, holding over the entire periphery, is employed. When machining is completed the unloading lever picks off the part and transfers it to the third magazine in the manner previously described.

On the third machine the loading lever picks a component from the third magazine and transfers it to the stationary 3-jaw chuck which serves as a workholder. When drilling is completed and the multiple drilling head mounted on the machine slide is retracted, the unloading lever picks off the part and swings it to a stripping fixture. This is a simple device consisting of an apertured plate furnished with three spring latches. Axial movement of the lever forces the part past the latches and through the aperture. Reversal of the movement withdraws the gripping device and leaves the part free to pass down the delivery slide for collection or subsequent transfer as may be desired.

The longest operational cycle, determining the cycle time for the complete line, is 1·3 min, giving a potential production rate of 46 pieces/hour. Providing the magazines are fully loaded, up to twenty minutes can be taken for tool change, minor adjustment, inspection, or maintenance on any one machine before the production flow is interrupted.

Representatives and selling agents for Max Müller Brinker Maschinenfabrik machines are Henry Pels and Co. Ltd, of 32-38 Osnaburgh Street, London, N.W.1.

Filtration Medium

SEVERAL advantages are claimed for Porosint Rigimesh, a new filtration material produced by Sintered Products Ltd, Sutton-in-Ashfield, Notts, a member firm of the Sheepbridge Engineering Group. This material is basically a woven wire mesh, but it is made rigid by furnace welding the wires of the mesh at all contact points. Produced in sheet form, Rigimesh can be fabricated into a wide variety of shapes. The standard wire used is an 18/8 stainless steel, but for special purposes metals such as Monel, Nimonic 75, bronze, and nickel can be used.

Porosity is strictly controlled during manufacture, and filters having porosity ratings ranging from 5 to 100 microns are in normal production. This range caters for most requirements, but a 2 micron filter can be made if necessary. It is stated that Rigimesh can be used for filtering fluids for which no other suitable medium has been found. The material is unusually durable in service, has a wide variety of applications and can readily be cleaned. Among the fabricating methods that can be used to produce filter elements are punching, cold forming, rolling, drawing, and arc or spot welding. According to the makers, it is possible to produce cylinders as small as $\frac{1}{8}$ in diameter.

Spring-Pin Ranges

TWO manufacturers have recently announced that they are producing ranges of spring-pins. One company is The Tempered Spring Co. Ltd, Sheffield, whose products have been designated Rollpin fasteners; the other is Unbrako Socket Screw Co. Ltd, Burnaby Road, Coventry, by whom the name Sel-lok has been adopted. In each case, the pins are of wrapped, tubular form. They have an appreciable axial gap in the unfitted condition, and the ends are externally chamfered to facilitate fitting.

The hole into which a spring-pin is inserted is drilled to a smaller diameter than that of the pin, which is therefore sufficiently radially compressed on insertion to resist vibration or relative movement. Nevertheless, the pin can readily be driven out when necessary. Pins of this type can be employed to replace rivets, screws or taper-pins in a variety of applications, and they have been used satisfactorily as keys, pivot spindles and hinge-pins.

Both products are made in a variety of diameters ranging from $\frac{1}{16}$ in to $\frac{1}{2}$ in; in each diameter, there is a wide choice of lengths. Whereas the Rollpin fasteners are available in carbon or stainless steel forms, the Sel-lok items are of carbon steel only, cadmium plated to resist corrosion.





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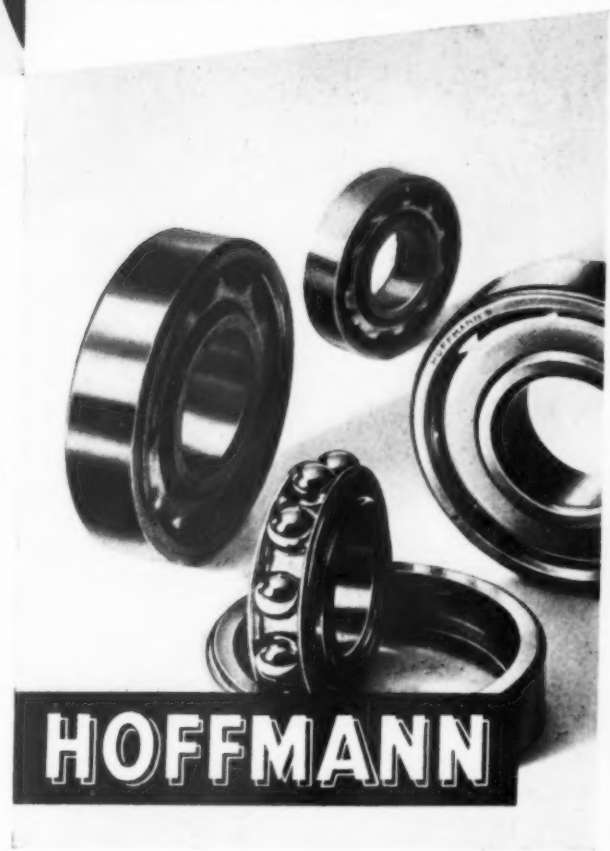
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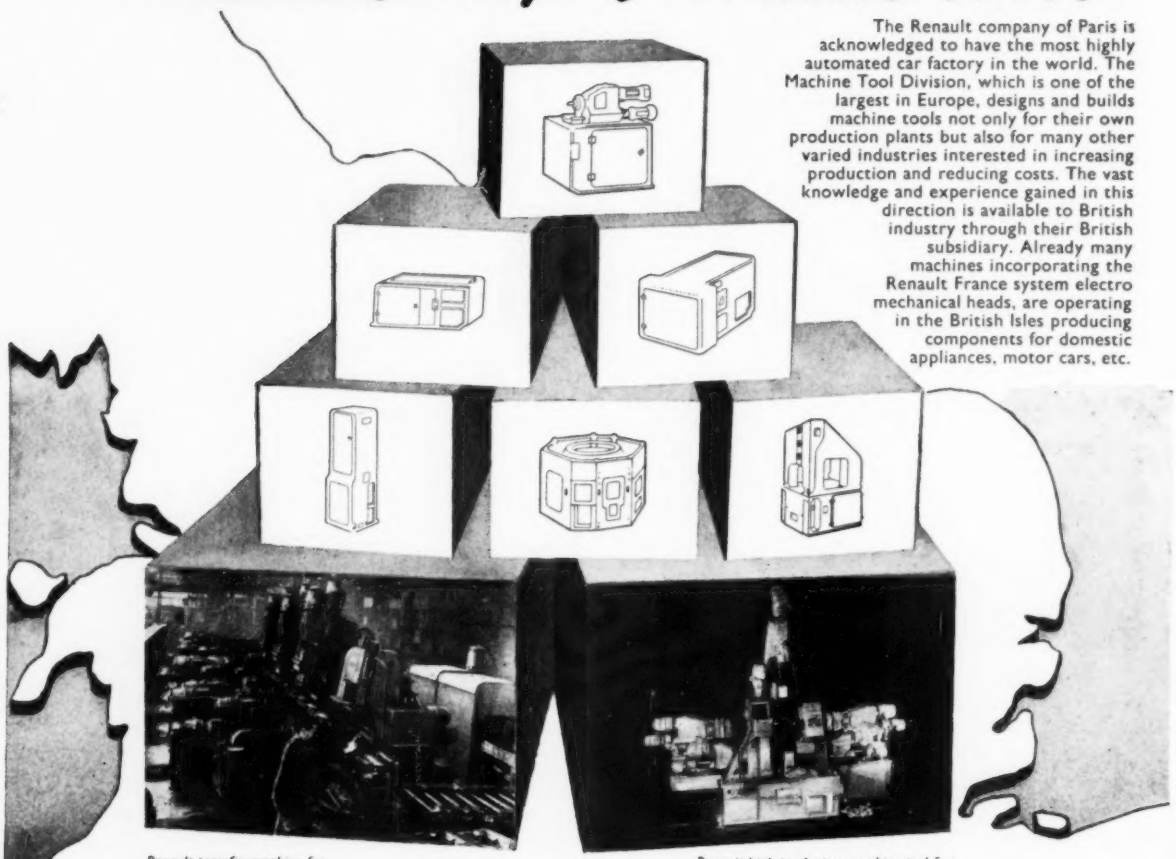
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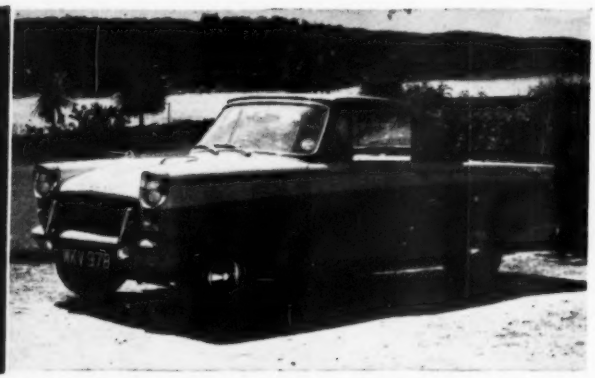
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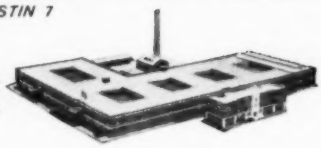
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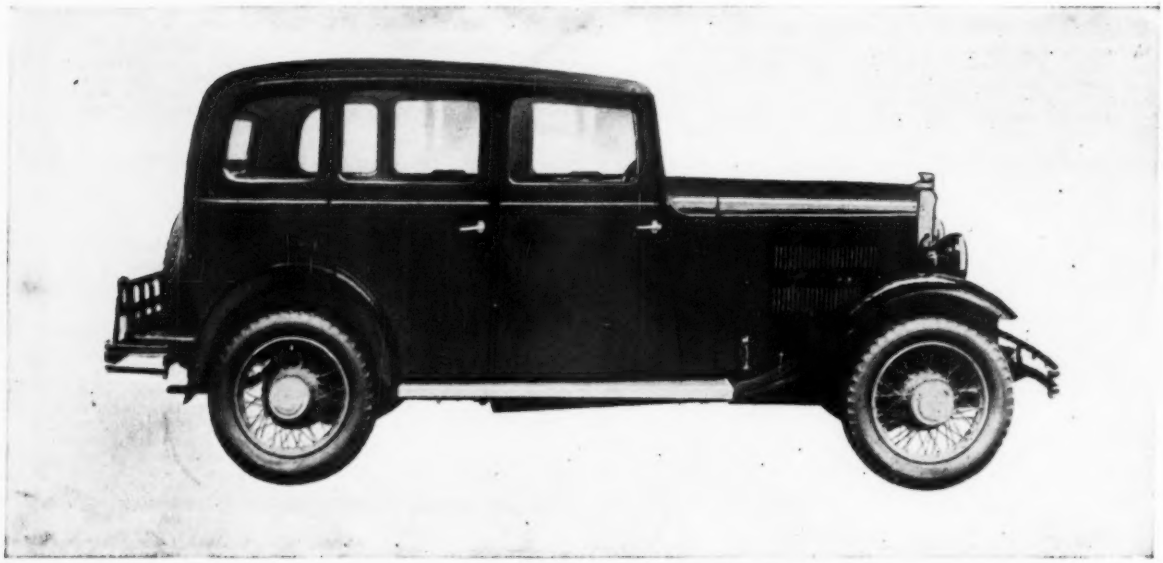
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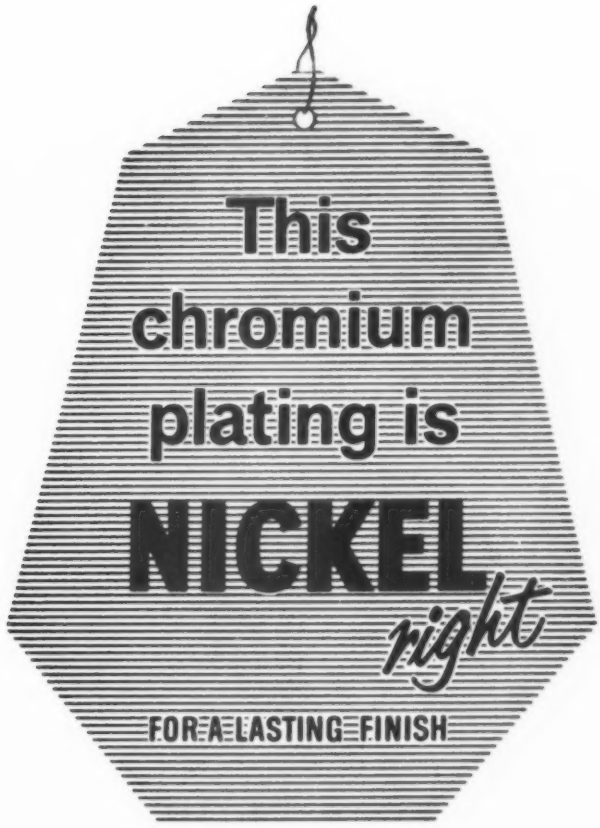
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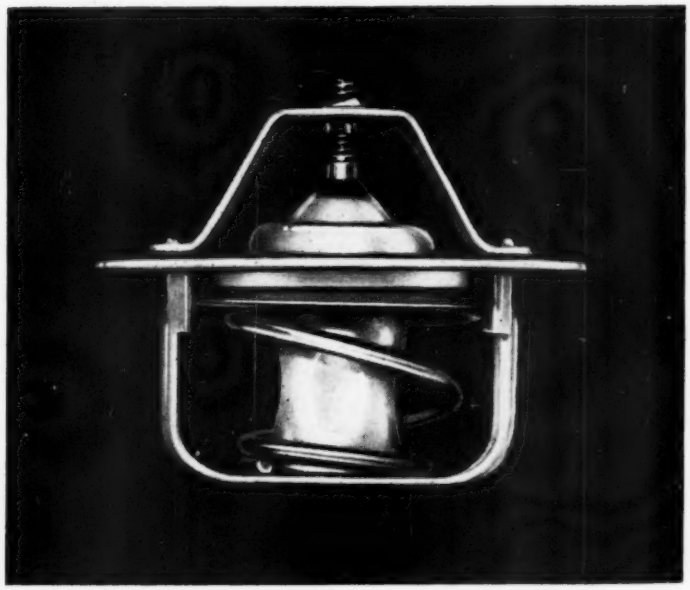
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Western Thomson wax element thermostats are specially built to withstand pressure and vibration. They are simple and robust. They are actuated by the expansion of solid wax, and they have no stressed metal parts to suffer fatigue. Consequently, they give long trouble-free service in engine-cooling systems.

Available for use with or without a by-pass, and start-to-open temperature setting from 85° to 185°F.



WESTERN THOMSON

CONTROLS LIMITED

A MEMBER OF THE ADAMANT AND WESTERN GROUP OF COMPANIES

THE AERODROME · READING · BERKSHIRE · TELEPHONE: SONNING 2351 · TELEGRAMS: 'HAWK' READING



both ends simultaneously!

MILL, DRILL, FACE, CENTRE, BORE, TURN, REAM, CHAMFER, TAP... in Selective automatic sequence plus automatic handling

CUT YOUR COSTS IN HALF

with the tool rotating

'ENDOMATIC'

* UP TO SIX TOOLING STATIONS
* A COMPLETE RANGE OF MODELS TO MEET ALL PRODUCTION NEEDS

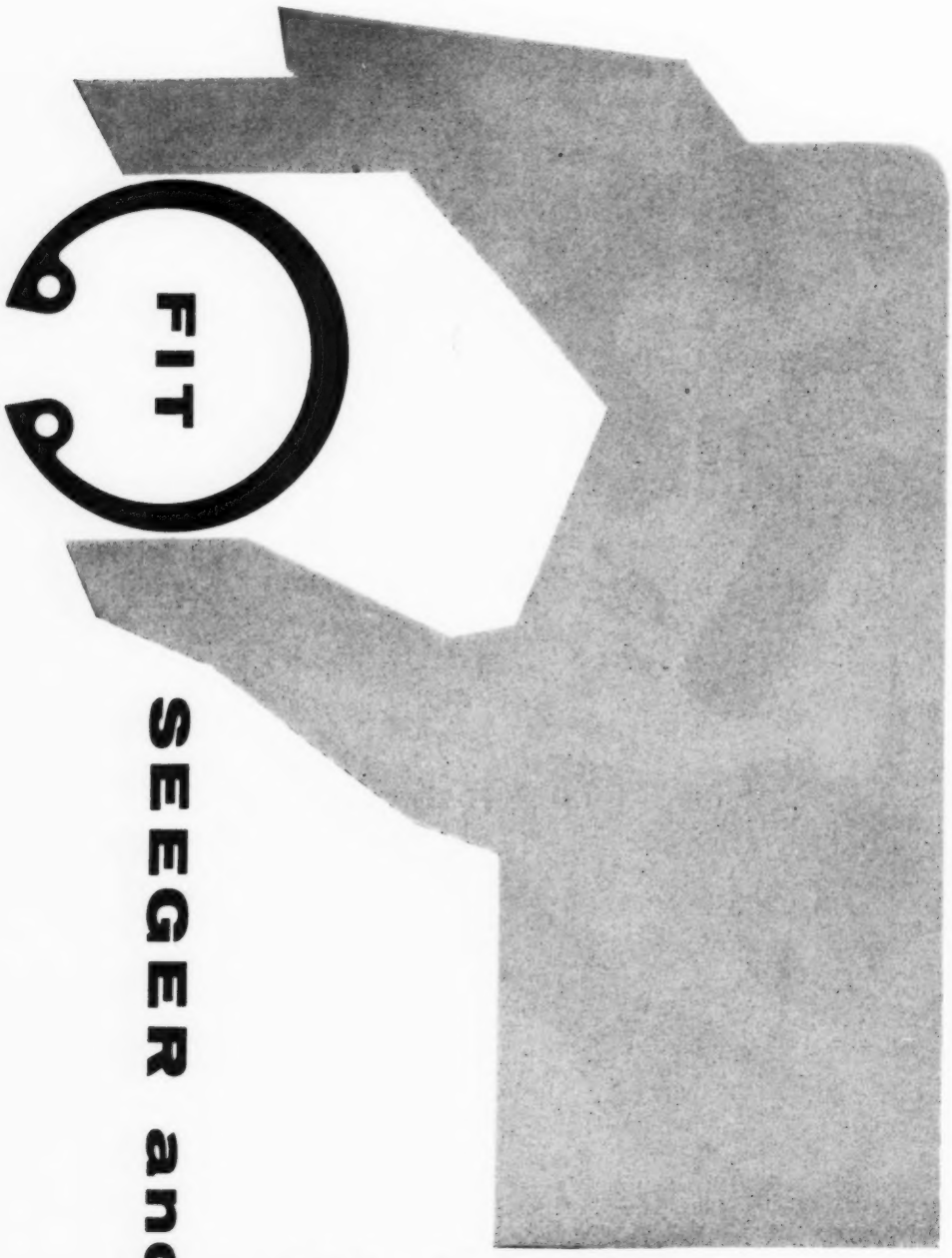
ENQUIRE NOW As to just where and how the 'Endomatic' can cut your production costs

★ COMPLETE ENGINEERING SERVICE AVAILABLE ON YOUR OWN PROBLEMS

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SOLE AGENTS FOR U.K.: SYDNEY G. JONES LTD., 8 BALHAM HILL, LONDON S.W.12. TEL: BATTERSEA 3246

FRASER



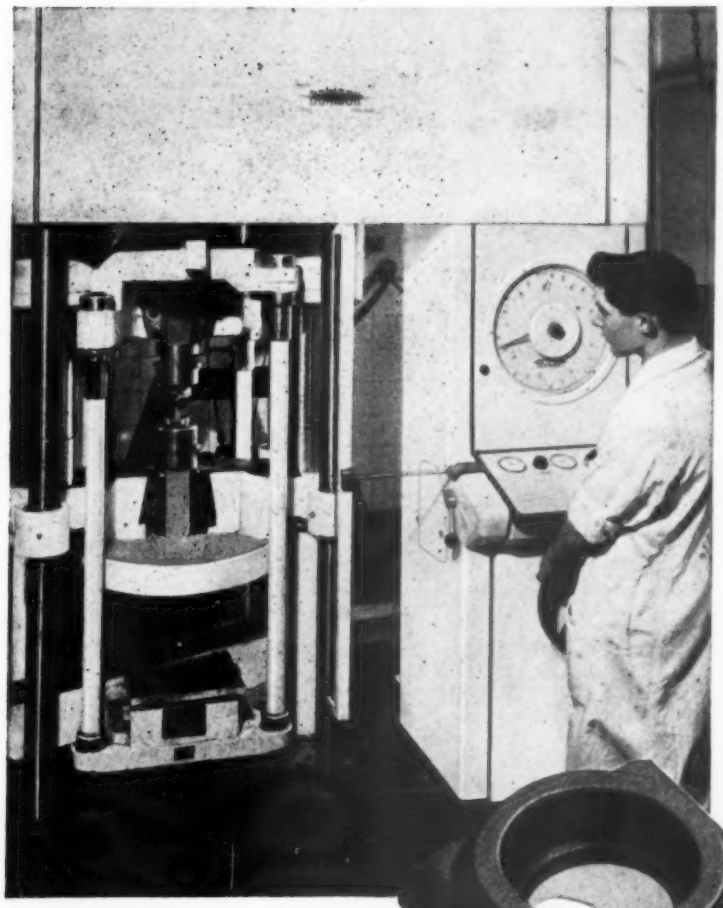
FIT SEEGER and BE SURE

Automotive Engineering Limited

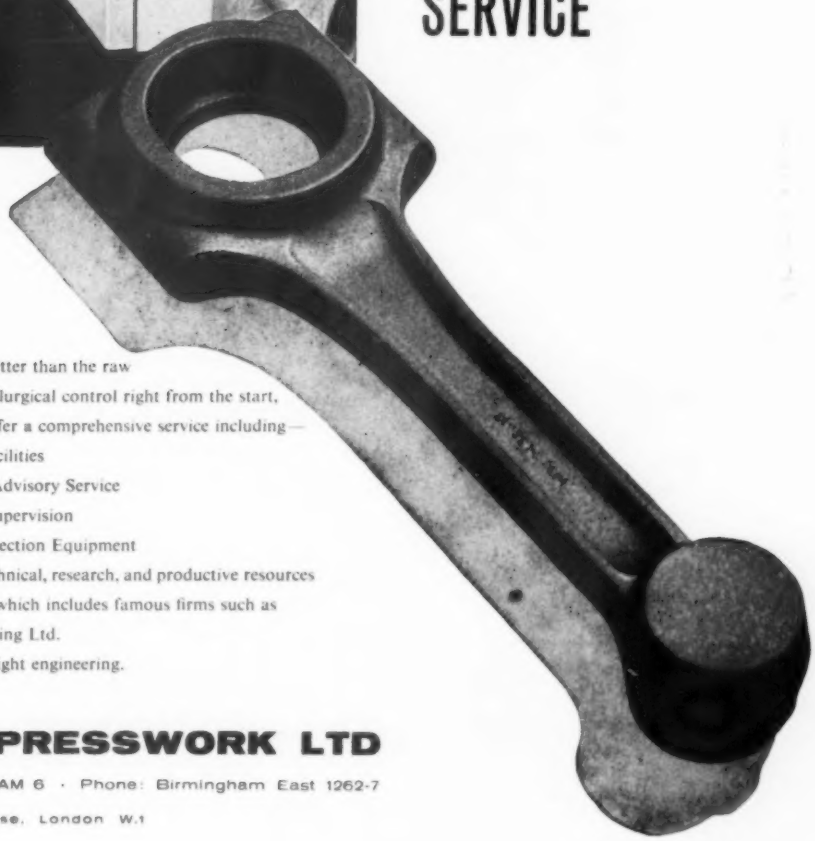
The Green, Twickenham, Middlesex
Telephone: POPesgrove 2206/9
Telegrams: Motif Twickenham

ONE OF THE SHEEPBRIDGE ENGINEERING GROUP

SEEGER CIRCLIPS ARE ON THE ROLLS-ROYCE APPROVED LIST



it all adds up to COMPREHENSIVE SERVICE



Metallurgical Control of Raw Materials . . .

The finished product can never be better than the raw material allows: in addition to metallurgical control right from the start, FORGINGS AND PRESSWORK LIMITED offer a comprehensive service including—

Up-to-date Plant and Production Facilities
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This Company participates in the technical, research, and productive resources shared by the whole Birfield Group, which includes famous firms such as Hardy Spicer Ltd. Laycock Engineering Ltd. and other companies well known in light engineering.

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GLACIER *DU for AEC





AEC Routemaster King-pin assembly fitted with DU bushes.

DU dry bearings are proving their worth on an increasing number of vehicles, including the A.E.C. Routemaster. Many leading firms use them in brake and clutch mechanisms, power steering mechanisms, throttle linkages and centrifugal clutch flywheels. They need no lubrication, have a high load-carrying capacity with a lower friction coefficient, eliminate stick-slip, afford protection from abrasive particles, and reduce wear, fire risk and cost. DU dry bearings are made exclusively by GLACIER.

* Glacier DU dry bearings are composed of thin steel strip with a porous bronze coating impregnated with a mixture of a fluoro-carbon plastic (P.T.F.E.) and lead.

GLACIER

D.U. for COMMER



DU Thrust washers fitted as standard equipment on the ¼ ton range of vehicles.

D.U. for GUY



DU dry bearings and bushes fitted as standard equipment on brake, clutch and steering mechanisms and on throttle linkage on the Wulfrunian bus chassis.

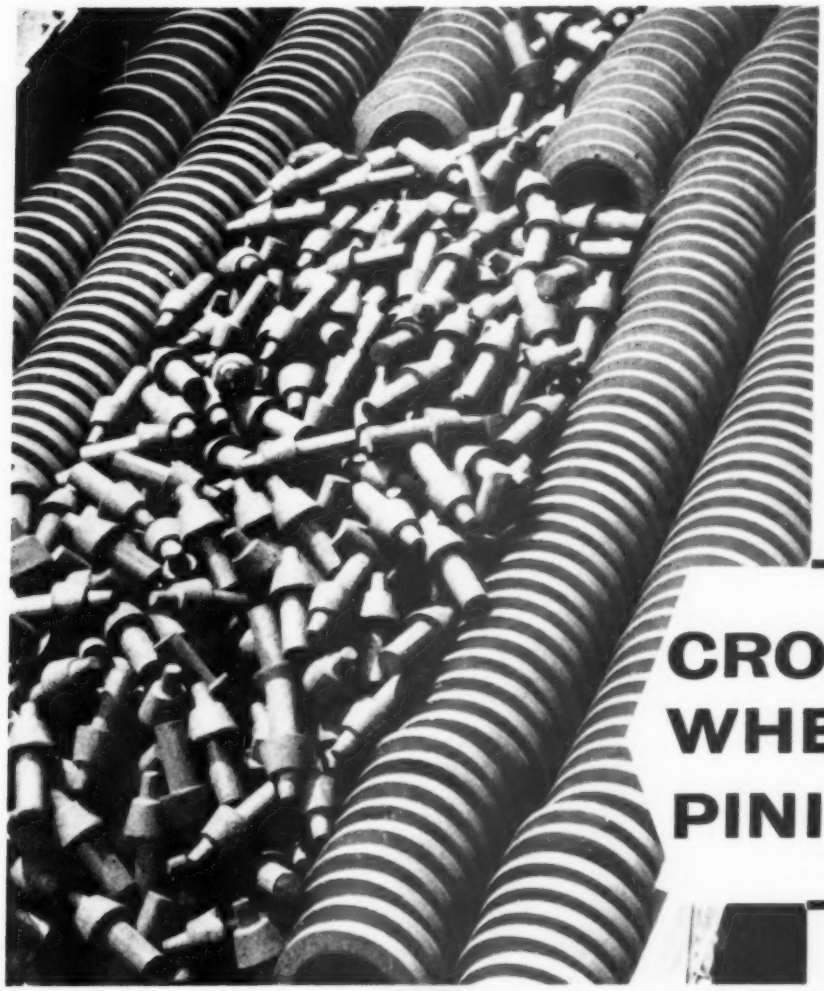
D.U. for Albion



DU Thrust washers fitted as standard equipment on steering pivot pins of the Series II Chieftain.

For details of the range and properties of Glacier dry bearings, write for a free copy of the Designer's Handbook No. 2 to :—

THE GLACIER METAL COMPANY LTD · ALPERTON · WEMBLEY · MIDDLESEX



CROWN WHEELS and PINIONS

A vital contribution to the efficiency and reliability of cars and trucks

supplied by

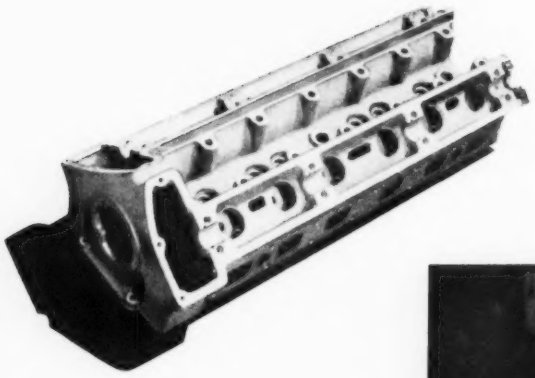
FIRTH-DERIHON

SHEFFIELD & DARLEY DALE

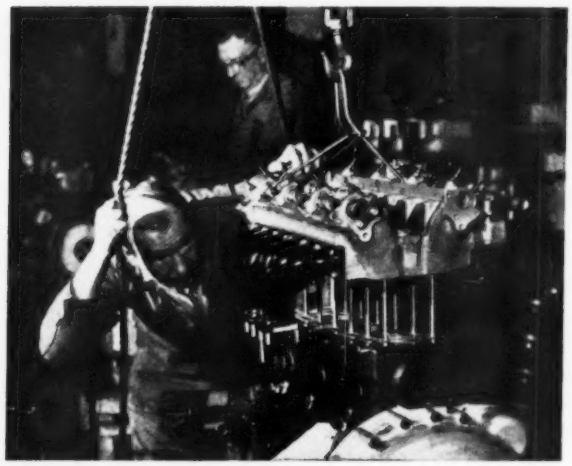
High Quality Drop Forgings
for the Automobile and Aircraft Industries

THE FIRTH-DERIHON STAMPINGS LIMITED, SHEFFIELD.

On with her head!



For many years, William Mills have supplied aluminium castings for the cylinder heads, sumps and manifolds of Jaguar cars. The range of Mark 2 models, introduced for 1960, uses similar castings in LM4 alloy, and the intricate cylinder head casting shown is a fine example of modern foundry technique.

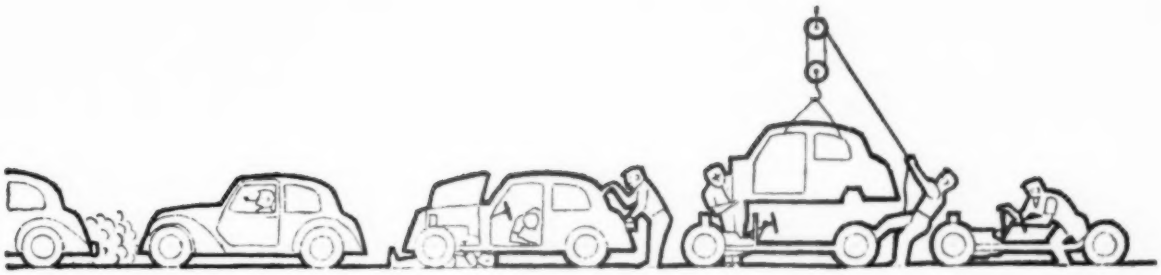


Aluminium alloy castings by

William Mills Limited



WILLIAM MILLS LIMITED, FRIAR PARK FOUNDRY, FRIAR PARK ROAD, WEDNESBURY, STAFFS.
AP132



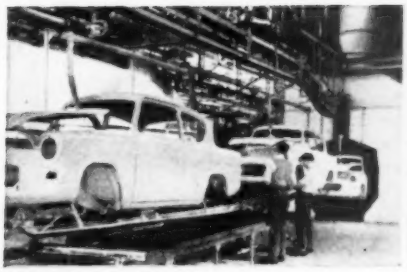
WHODUNITRY or who solved the problem?

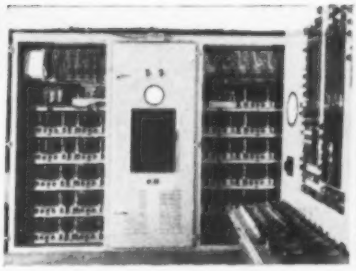
In the 'good' old days when labour was indeed hard LABOUR! and factory space was overloaded with cumbersome machinery, engineers were beset by many problems, tending more and more towards AUTOMATIC speed-variation and speed-control.

Many of these problems could not be solved by conventional electric or hydraulic drives, but they have yielded to the skill and experience behind the

HEENAN DRIVES

— the AJUSTO-SPEDE, DYNASPEDE







FORD too – have chosen Heenan Variable-Speed Couplings, for driving the Conveyors in their new Paint, Trim and Final Assembly building. These Drives are also in use at their Associate Company's Australian Plant. Heenan Drives have been supplied to the major car manufacturers including B.M.C. (Austin and Morris), STANDARD, VAUXHALL, SIMCA, VOLVO, etc., etc.

Remember - There is no substitute for experience

H&F

HEENAN & FROUDE LTD • WORCESTER • ENGLAND

Speetog Vertical Lift Clamp | Model ST 210

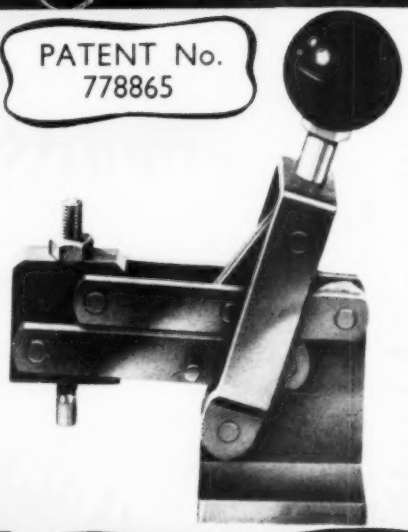
REGD. TRADE MARK

Due to its unique system of linkage, this clamp has two outstanding features. Firstly, the spindle travels in a vertical direction substantially throughout its travel so that it is possible to clamp into or through locating holes. Secondly it can be operated in a very confined space and providing there is 4" available behind the component being clamped, or a total space of $5\frac{3}{4}$", for instance between pillars then this clamp can be operated satisfactorily.

PATENT No. 778865



Fully Open Position Shows Space Economy. This Clamp Can Be Used in a Confined Space of $5\frac{3}{4}$"



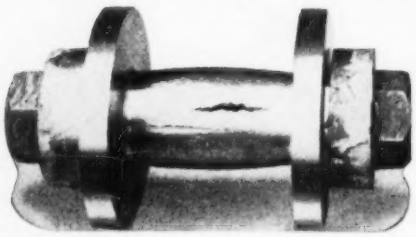
Speed Tools Ltd

VEREKER HOUSE, GRESSE ST., LONDON W.1. Museum 1039/1099.

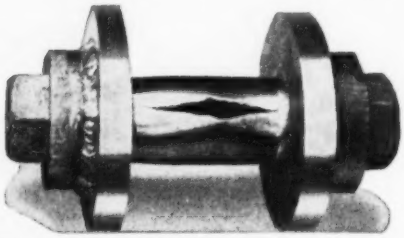
Literature on Request

NRP 9083

Remarkable performance of Aluminium Bronze



Gun-metal **0·25 in.** *thick—burst at 4480 lb. per sq. in.*



Aluminium-bronze **0·10 in.** *thick—burst at 4816 lb. per sq. in.*

0·10 IN. SHELL WITHSTANDS OVER 2 TONS PER SQ. IN.!

Recently we tested to destruction two similar hollow castings—one in gun-metal, the other in aluminium-bronze. The gun-metal had a wall thickness of **0·25 in.** and withstood pressures up to 4480 lb. p.s.i.—a very good performance. The casting in aluminium-bronze burst at a slightly higher pressure (4816 lb. p.s.i.) **but its wall thickness was only 0·10 in.** Surely an impressive demonstration of the weight/strength characteristics of this alloy.

We were one of the first foundries to cast in aluminium-bronze and to-day we supply castings in this alloy to customers all over the world.

CASTINGS FROM A FEW OUNCES TO 10 TONS...

in all non-ferrous alloys. Precision machining. Specialists in aluminium-bronze, centrifugal-cast wheel blanks. Shell-moulded castings and chill-cast rods and tubes. Continuous cast phosphor-bronze bars up to 12 ft. lengths.

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NON-FERROUS CASTINGS, HIGH-DUTY IRON CASTINGS
PRECISION-MACHINED BUSHES AND BEARINGS

Send your enquiries to:

T. M. BIRKETT, BILLINGTON & NEWTON LTD

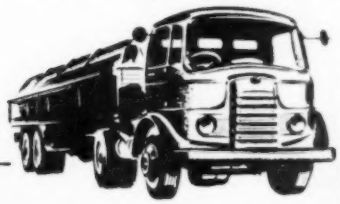
HANLEY AND LONGPORT, STOKE-ON-TRENT, ENGLAND

Head Office: HANLEY, Phone: Stoke-on-Trent 22184/5/6/7. LONGPORT, Phone: Newcastle, Staffs, 51433/4

The commercial vehicle industry has waited years for this—the new Simms filter

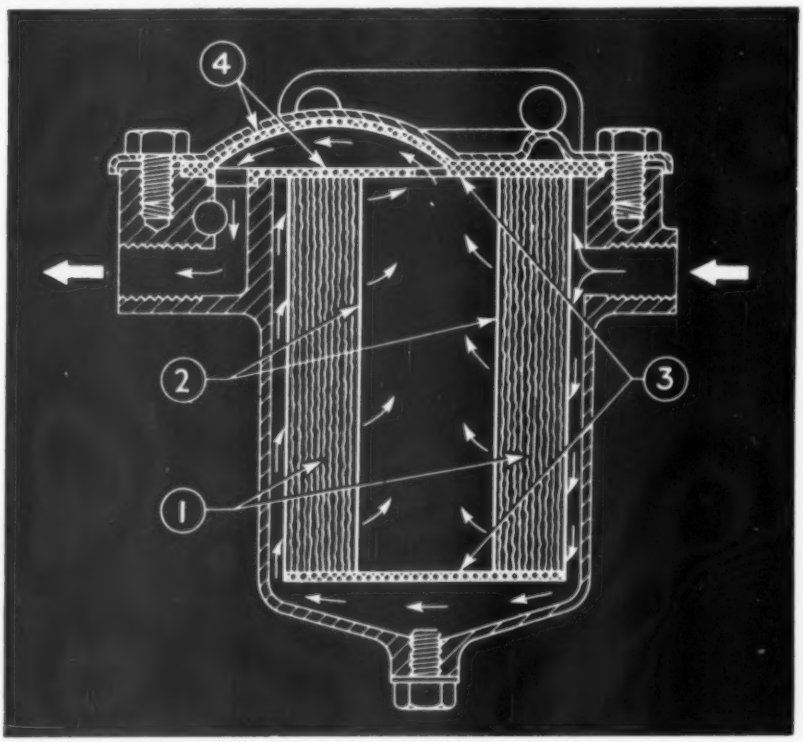
Its filtering efficiency is 98% down to particles as small as 2-4 microns

This is the highest efficiency of any commercial fuel filter made anywhere in the world



It is the simplest of filters to maintain

Particles below 5 microns are too small to be harmful, there is therefore no point in trying to remove them. All larger particles are removed completely, thus eliminating damage to fuel pump and injectors.



Look at these features:

1. Extra Large area, corrugated element giving long life
2. Inward flow: clean side of element always faces inside
3. Moulded ends completely protect all clean surfaces from dust
4. Upper end of filter-element forms all seals. There are no loose bits to cause trouble on assembly

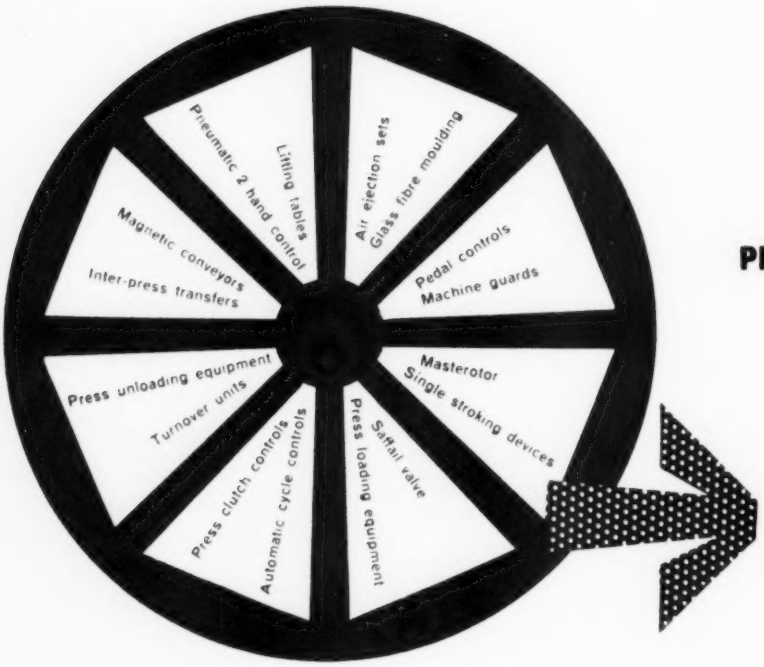
Replacement of the element is so simple that it can be done by an unskilled operator with complete certainty that the filter will function properly.

SPECIFY IT ON NEW ENGINES, FIT IT TO THOSE ALREADY IN USE

Simms

You can get full details from

SIMMS MOTOR UNITS LTD., LONDON, N.2



PRESS SHOP SERVICES

UDAL GROUP

J. P. UDAL LIMITED, Interlock Works Court Road, Birmingham 12. Telephone: Calthorpe 3114/6.



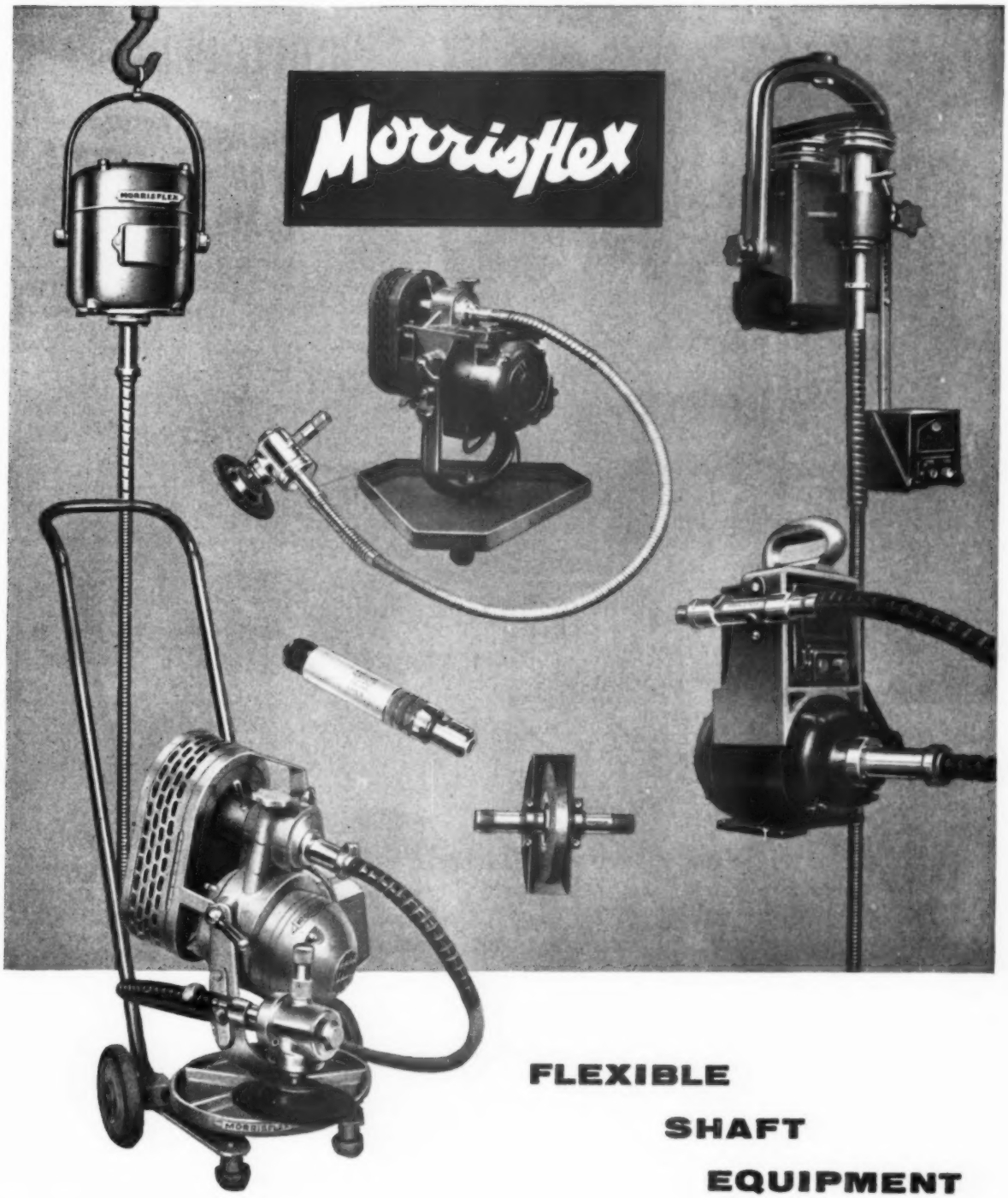
WILEY

Whatever your fastening problem, Wiley can make a bolt for it—and a nut too—ask them!

make a bolt for it!

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M-W.61



FLEXIBLE

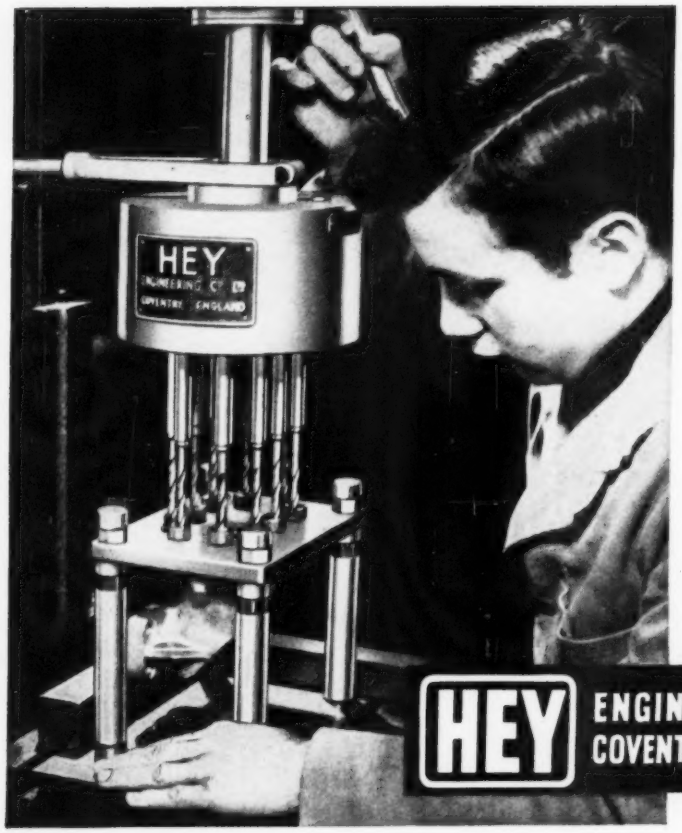
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MULTIPLE DRILL HEADS

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Hey Multiple Spindle Drill Heads convert Standard Drilling and Boring Machines to High Production Machines permitting drilling of all holes in a component simultaneously, with production rates equal to those obtainable on expensive special purpose machines.

Compact design reduces to a minimum, distance from drill head to machine spindle, whilst careful selection of material ensures an extremely efficient light weight head.

Heads are available with any number of spindles, covering a wide range of sizes

MAXIMUM PRODUCTION ON DRILLING, REAMING, TAPPING AND SPOT FACING OPERATIONS

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We also manufacture Rotary Cam and Profile Milling Machines, Short Thread Milling Machines, Gear Tooth Rounding Machines, Tapping Machines, End Facing and Centring Machines, Special Machine Tools for High Production.

NRP 1598

TRIPLEX

For High Duty Grey Iron

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SOLE MANUFACTURERS OF

CROMLEX

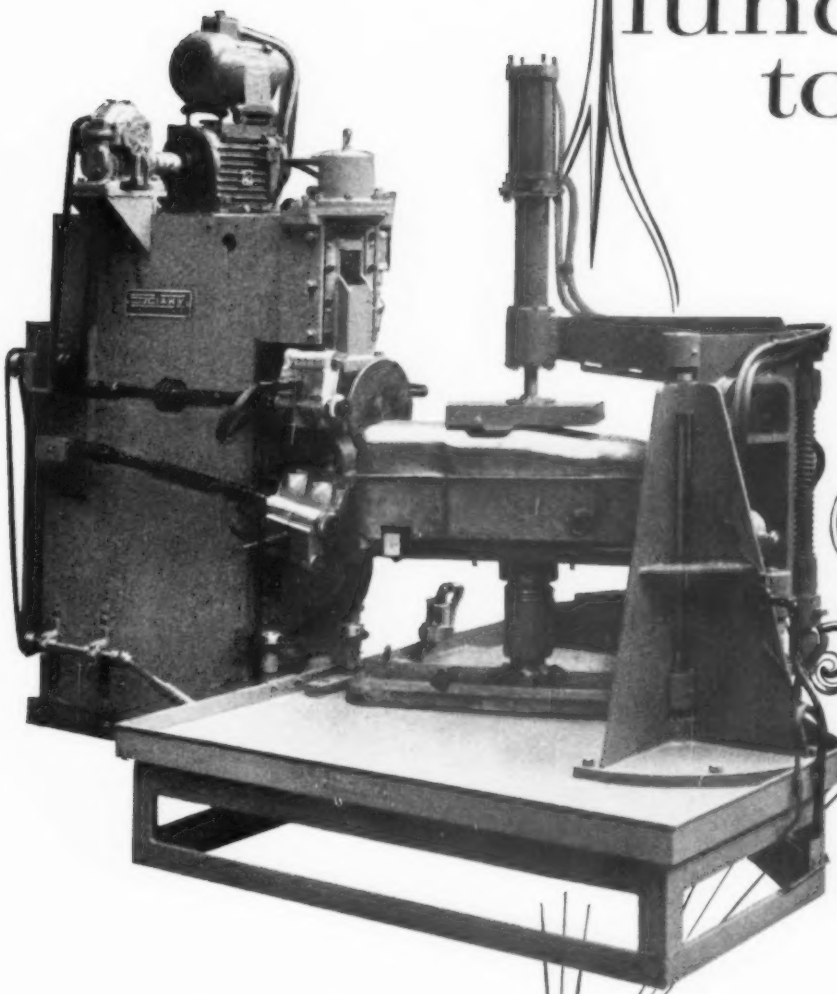
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A MEMBER OF THE TRIPLEX FOUNDRIES GROUP

We make CASTINGS in Both Large & Small quantities for **ALL TRADES**

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no lunch today...



'THE IRON MAN'

or any day

IT WORKS THE CLOCK ROUND

Sciaky 'Iron Man' needs no lunch . . . works 24 hours a day—another example of Sciaky ingenuity. The 'Iron Man' device was the low cost answer to motor manufacturers problem of fabricating pressure-tight vacuum and petrol tanks at high speed using unskilled labour.

All that is required of the operator is to load the half pressings and remove the completed component. This successful application is the direct result of the adaption of resistance welding to the application—the Sciaky technique—get on to Sciaky ingenuity, it can work for you too!

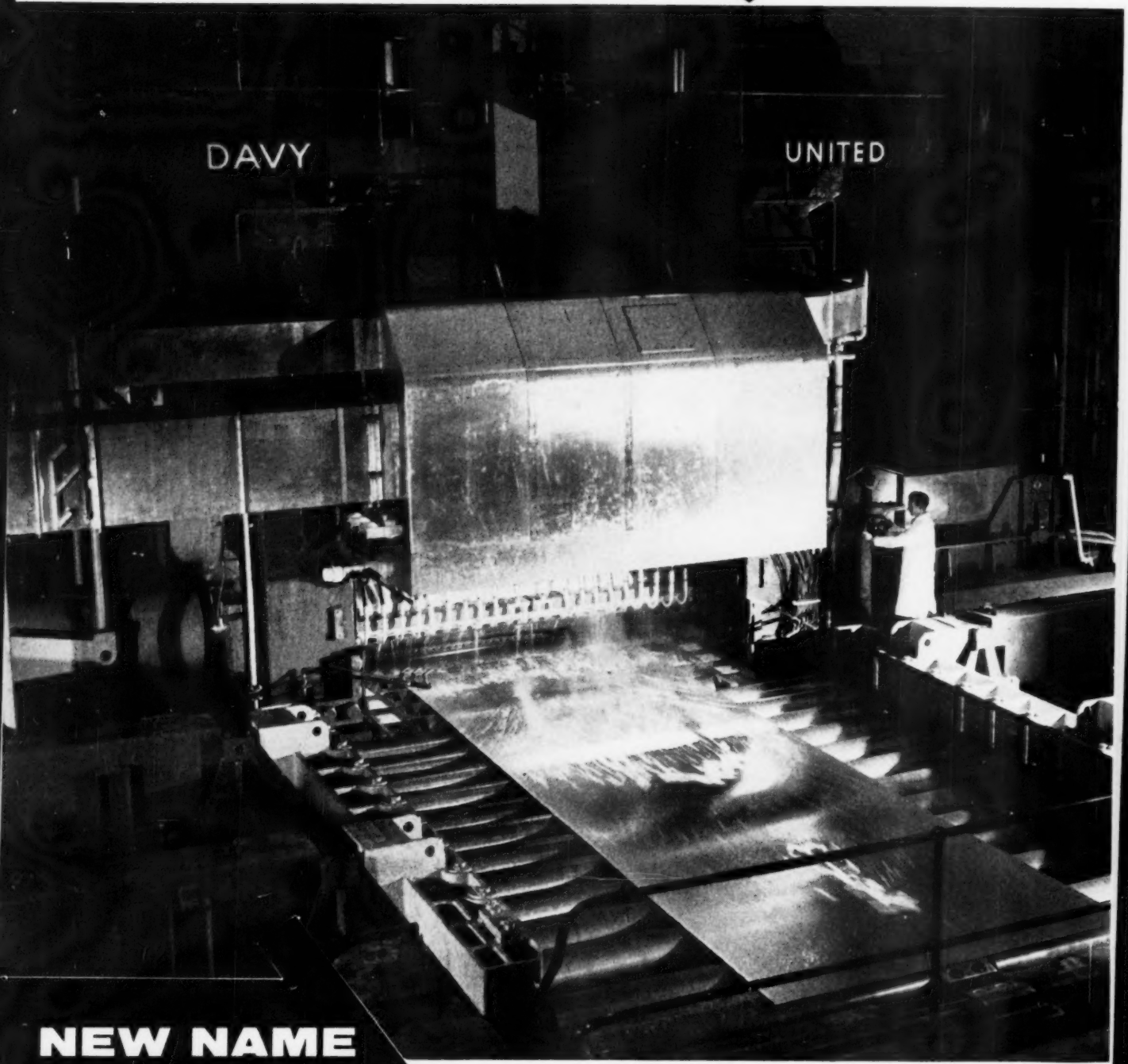
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The largest

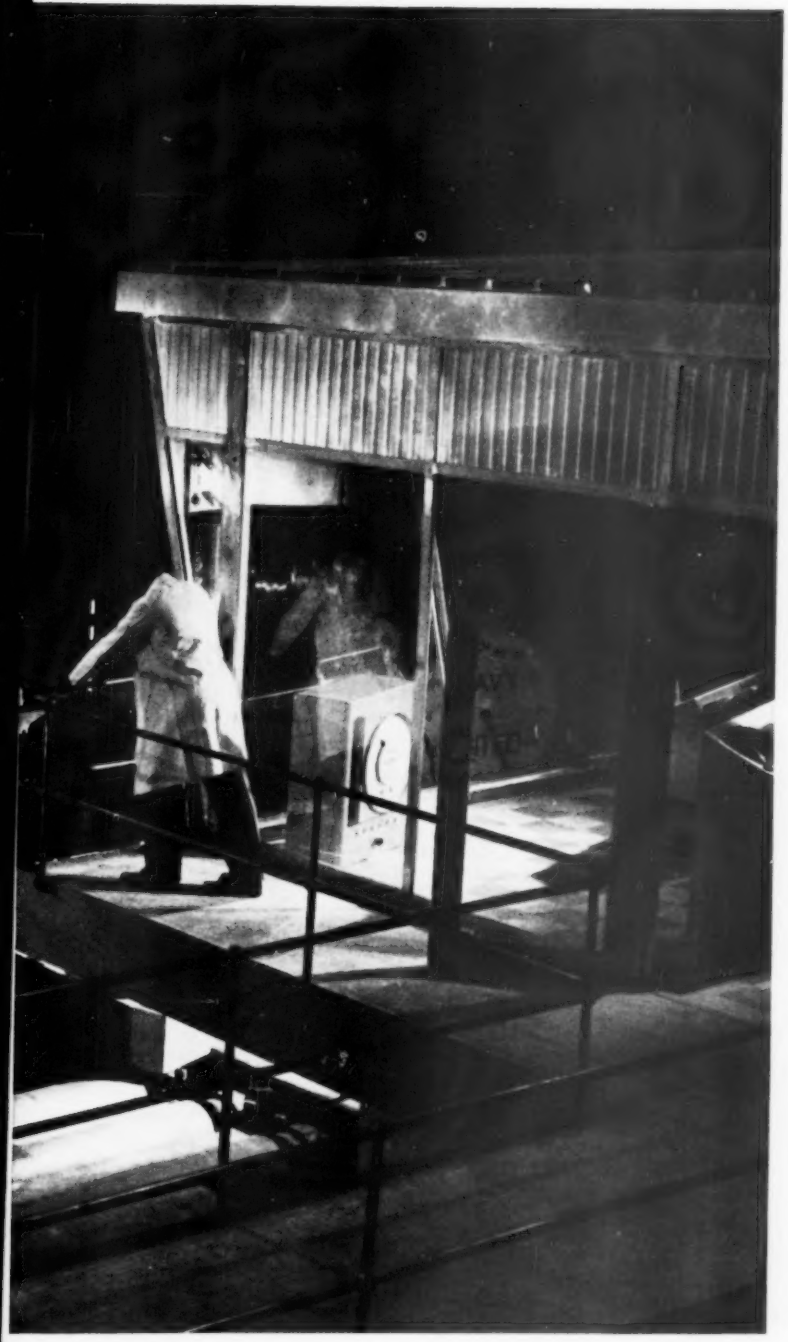


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aluminium rolling mill in Europe



This 8,000 horse-power 144-inch mill, first stage in a 'hot line' one third of a mile long, is the centrepiece of the latest expansion of the continuous strip mill at Rogerstone, Monmouthshire. New equipment and modernisation at a cost of over £7 million makes Rogerstone the largest aluminium rolling mill in Europe, with a nominal capacity of 70,000 tons of sheet and strip products a year, plus a substantial extra capacity for hot-rolled coil and plate.
It demonstrates the determination of Alcan Industries – the new name of Northern Aluminium Company – to maintain their position as leading suppliers of aluminium products to British industry.
Leadership in equipment is backed by long experience in the application of aluminium, including joining methods. If you use, or might well use, aluminium, for expert advice get in touch with your nearest Alcan Industries (formerly Northern Aluminium) office.

LIMITED

This new name identifies the company more clearly as a member of the Aluminium Limited of Canada enterprise, comprising some fifty companies in all parts of the world. Emphasis is thereby laid on the advantages that the company and its customers enjoy in being able to avail themselves of the Group's extensive research and development resources, and its great fund of experience in the smelting, manufacture and application of aluminium.

ALCAN

A member of the
ALUMINIUM LIMITED OF CANADA
Group of companies

TBW 7/8



BIG NEWS FROM SMC

SINTERED METAL COMPONENTS (CHARD) Ltd



YOU our customers, have forced our ambitious expansion plans because

YOU know of our technical ability and "Service to Industry" policy, so

WE are "moving with the times" and moving our works location to our large new factory at Crewkerne and

WE can now offer a

MUCH LARGER

modern plant (*with far greater facilities*) and a

GREATLY INCREASED

force of representatives to serve you, our customers.

SINTERED METAL COMPONENTS (CHARD) Ltd

NOW more than ever you can specify SINTERED METAL for small components (circumscribed within a 4" dia. circle) in large quantities (no limit) *at less than half the conventional price.*

BODEN WORKS, CHARD, SOMERSET. *Chard* 2341/3 *Works phones: Crewkerne* 733/5

A member of the Sterling Industries Group.

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ENGINEERING AND TECHNICAL FACILITIES TO ENSURE QUALITY AND CONTROL AND TO PROVIDE SERVICE ON CASTING DESIGN AND TECHNICAL MATTERS

METALLURGICAL CONTROL
HIGH DUTY GREY IRON
HIGH STRENGTH & GOOD STRUCTURE
WEAR RESISTANCE
WITH FREE MACHINEABILITY

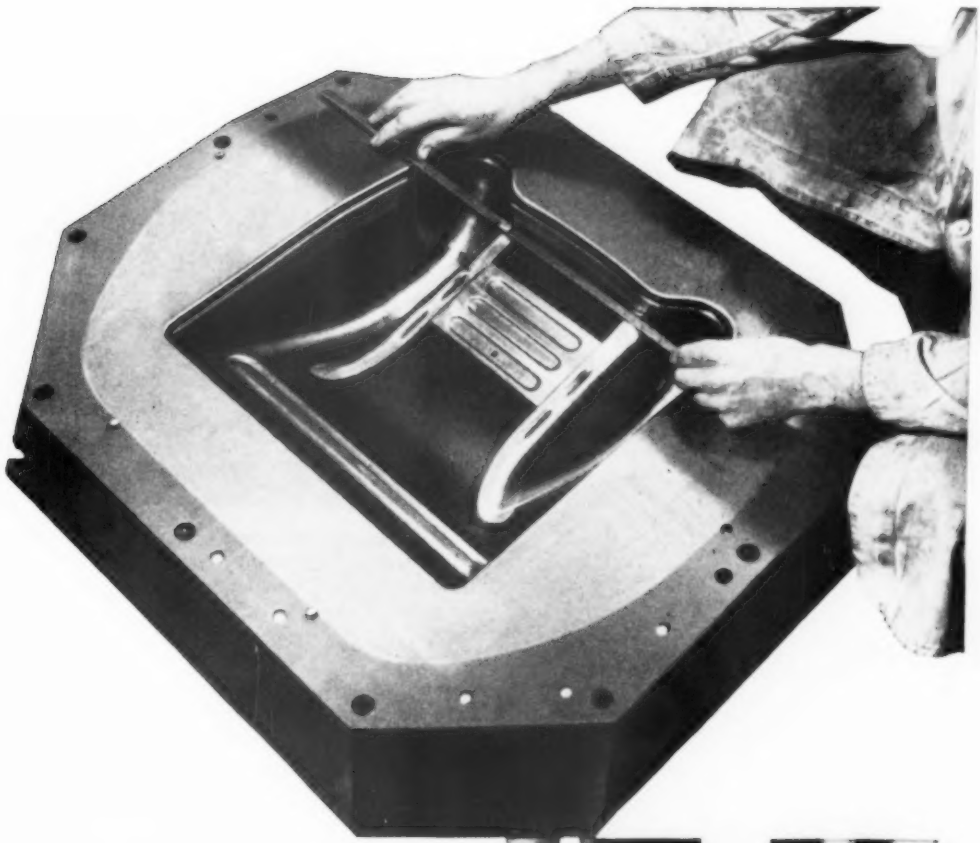
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SAND CONTROL
DIMENSIONAL ACCURACY
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CBS

SERVICE



Advanced Techniques

Engineers who habitually think in terms of advanced techniques know that epoxy resin dies offer savings in the cost of tools, whether for prototype, pre-production or short runs.
The punch and die shown are used by Ransomes Sims & Jefferies, Ltd. for pressing casings for one of their latest types of lawnmower. The final die and punch comprise low-cost cores faced with Araldite epoxy resin. This system provides press tools which are easily and quickly made, and cost less, so that Araldite tools show great economies in comparison with traditional metal equivalents. Production runs exceeding 8,000 pressings have been achieved with dies made from these materials. Modifications are simple and can be conveniently effected. May we send you our book "Araldite Resins for Tooling", which will give you design information?



Araldite

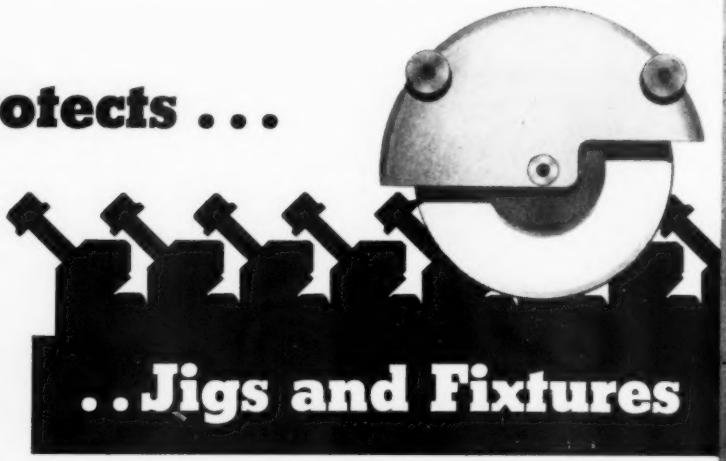
EPOXY RESINS

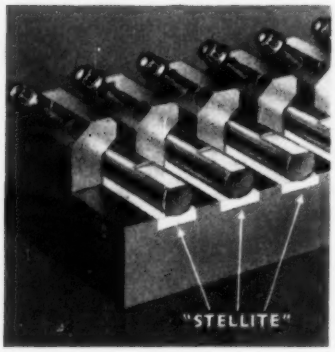
Araldite is a registered trade name

CIBA (A.R.L.) LTD., Duxford, Cambridge · Telephone: Sawston 2121

AP 584

"Stellite" protects . . .





. . Jigs and Fixtures

The application of "Stellite" stainless and abrasion resistant alloy to wear points of jigs and fixtures enables accurate component location to be maintained for long periods – thus reducing frequent replacement of holding equipment.

Details of the simple methods of applying "Stellite" are described in our publication SP.21 which is available on application.

DELORO STELLITE

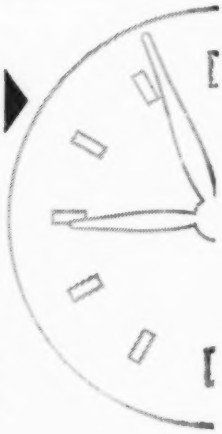
DELORO STELLITE LIMITED · HIGHLANDS ROAD · SHIRLEY · SOLIHULL · WARWICKSHIRE
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A BRITOOL set costs LESS than it SAVES in time. Available in ALL combinations and for ALL industries. Socket, Ring, Open jaw and many other wrenches in English, American, Unified & Metric sizes. Chrome Alloy Steel, superbly finished. Longest possible life.

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See our
Stand No. 479
Transport Service
Equipment Section
International Motor
Show 1960

Manufactured at
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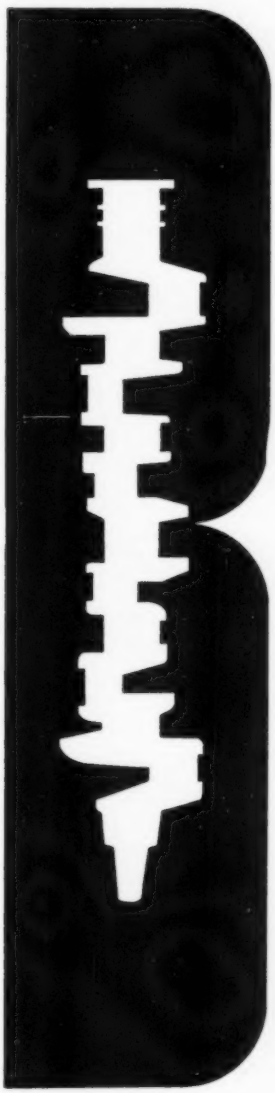
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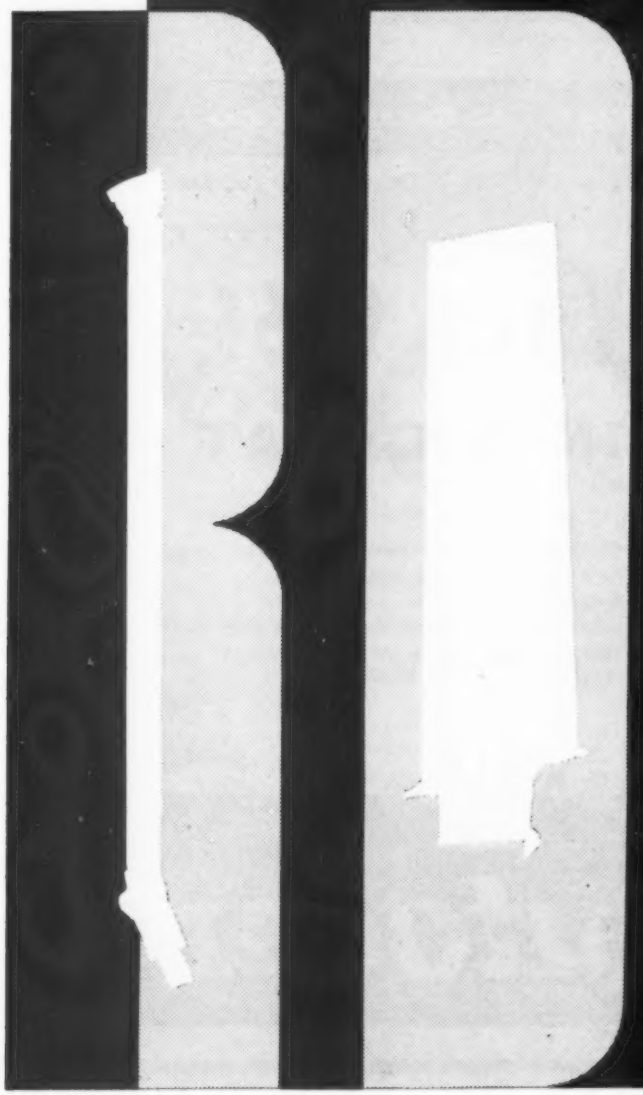












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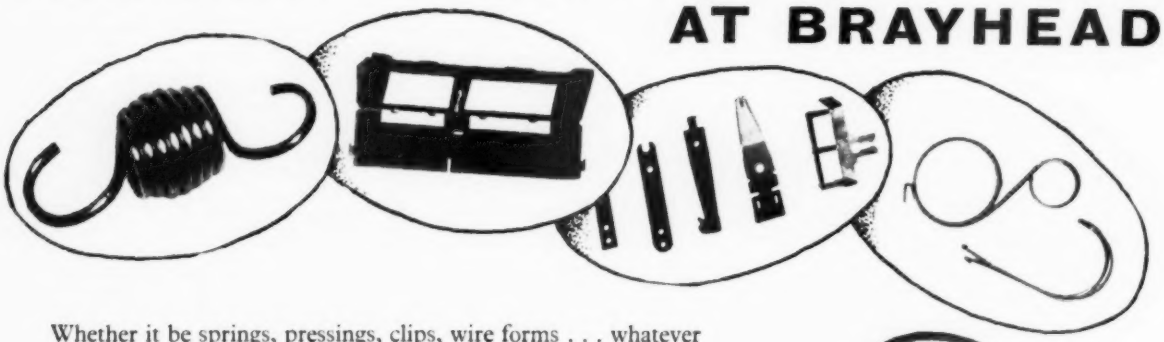
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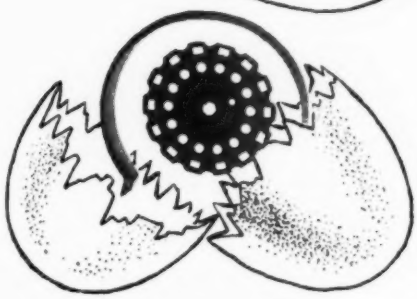
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Lima, 9th April, 1957

PERUVIAN OMNIBUS COMPANY LIMITED
J. BLUME T.
Principal of the Transport Department

The undersigned, PUBLIC NOTARY AND COMMISSIONER FOR OATHS, CERTIFIES that Mr. JUAN BLUME TRAVERSO, proving his identity with his electoral papers number six hundred fourteen thousand five hundred and ninety four and his military papers number eight hundred and seventy seven thousand six hundred and sixty two, was present in the offices of the aforesaid Public Notary, with the object of having legalised his signature in the DECLARATION which he has signed as Technical Principal of the Transport Department of the Peruvian Omnibus Company Limited, ratifying before me the said declaration which he now repeats and says as follows: "Herewith we wish to certify that Omnibus number two, of "SCANIA VABIS" make, Motor number sixty two thousand one hundred and seventy nine, Chassis number ninety one thousand nine hundred and seventy, which operates on the Lima-Ica Line, has run one million and two hundred thousand kilometres without it being found necessary to dismount the engine for repair", which he signs again in my presence, in Lima, on the thirteenth day of the month of April of the year one thousand nine hundred and fifty seven.

J. BLUME T.

DR. DANIEL CESPEDES
NOTARIO PUBLICO Y DE HACIENDA

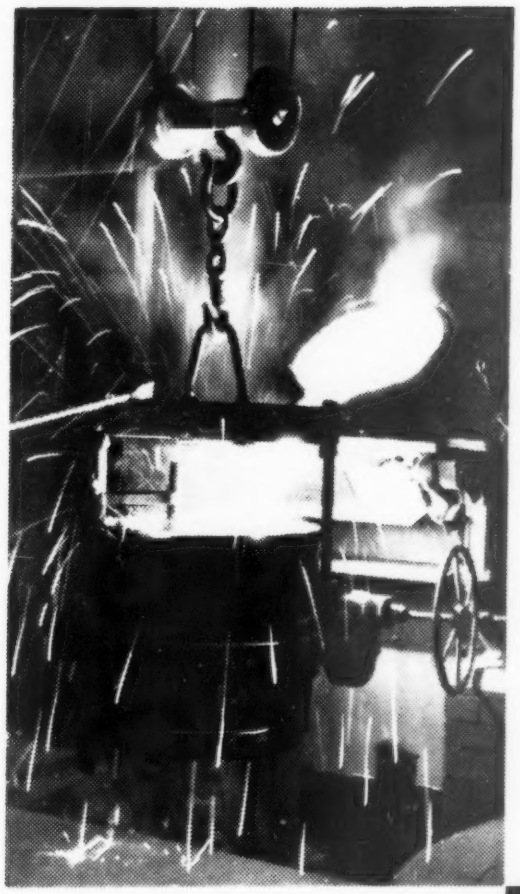
This is a translation of an affidavit drawn up by Dr. Daniel Cespedes, Notario Publico y de Hacienda.



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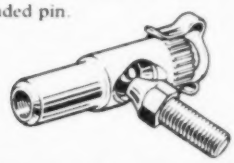
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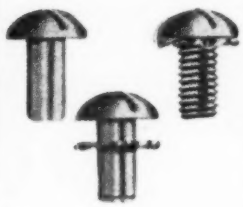
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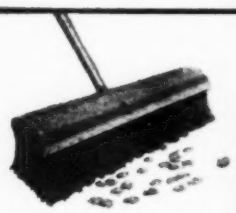
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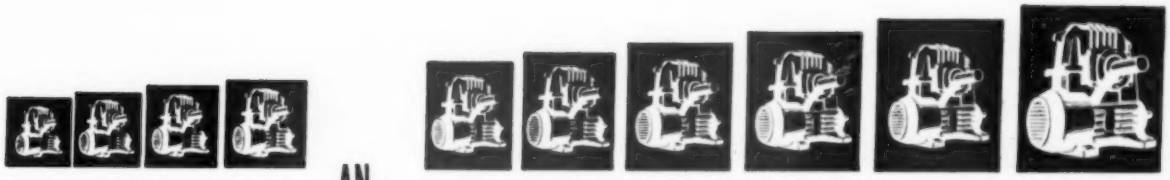
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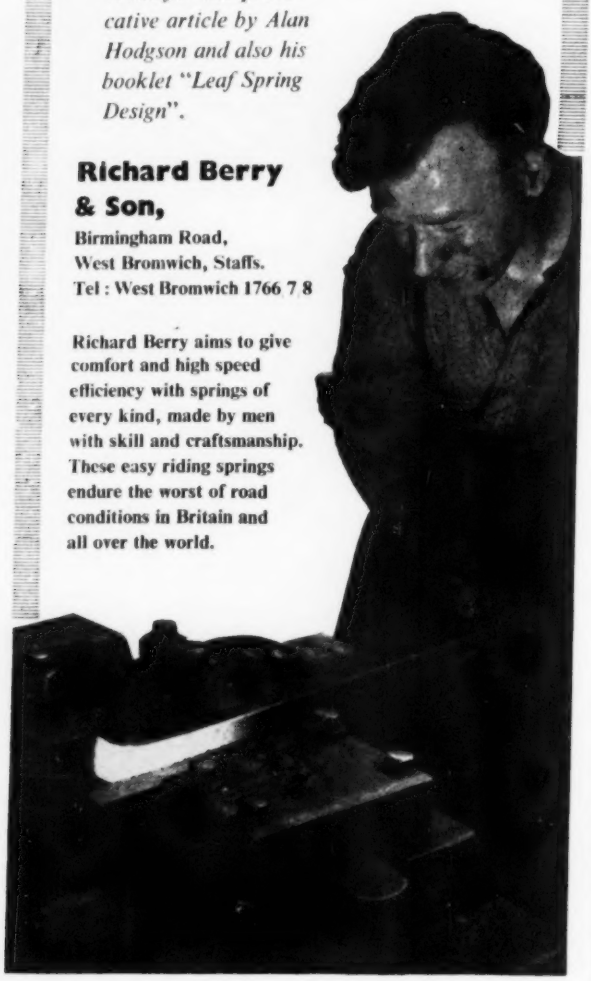
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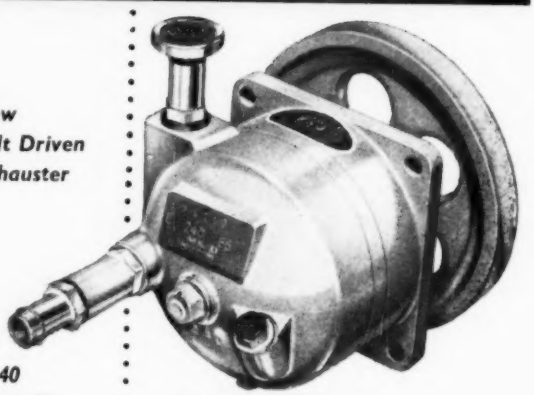
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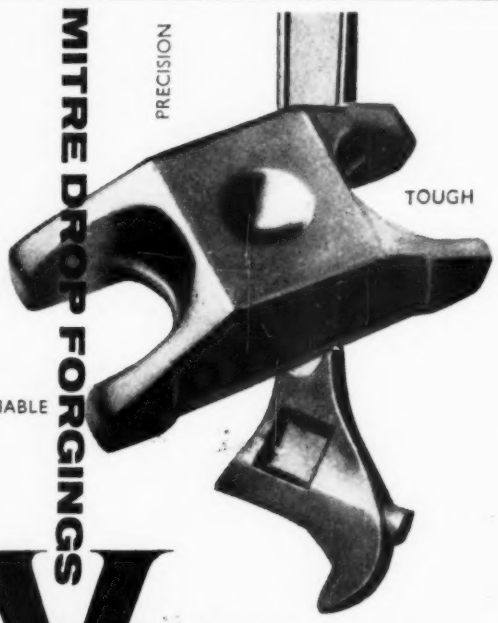
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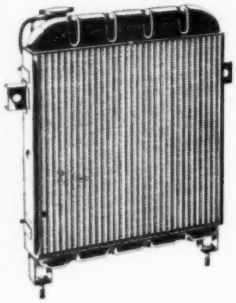
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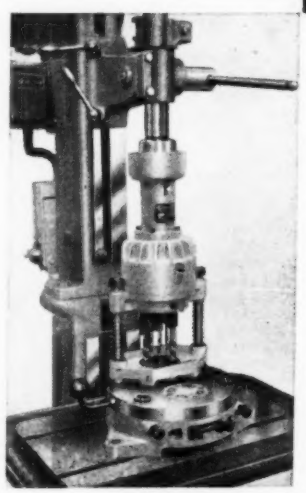
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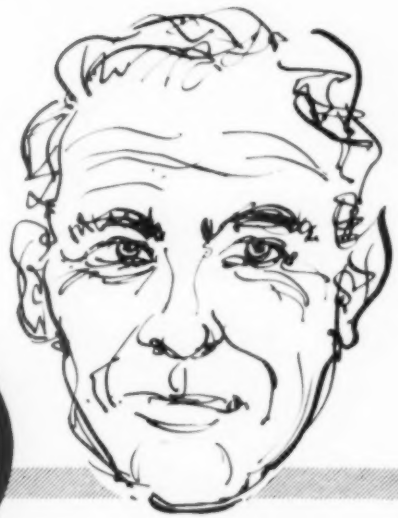
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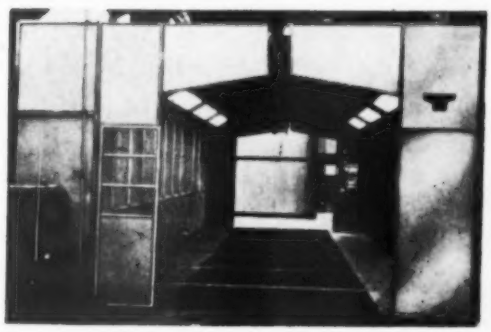
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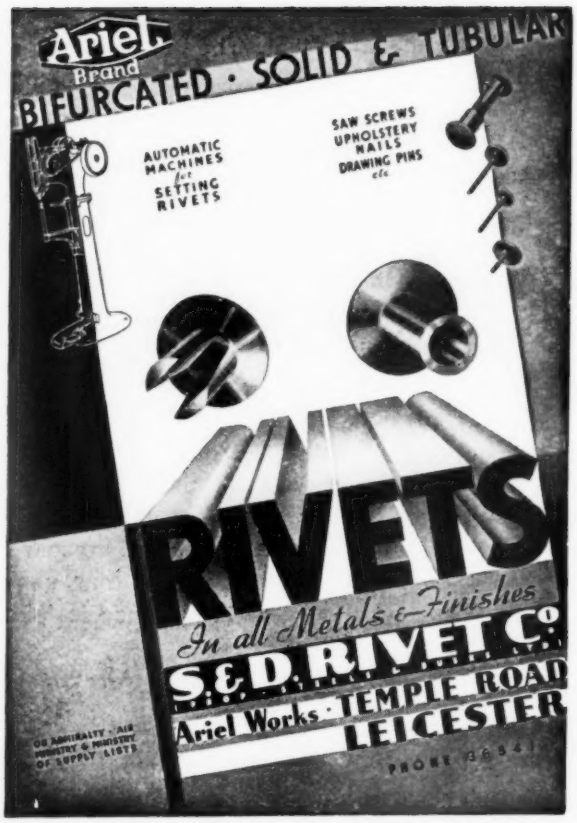
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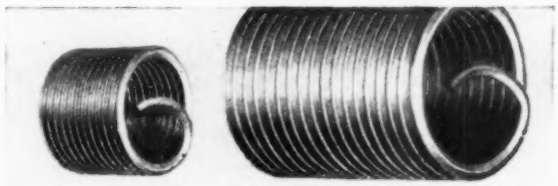




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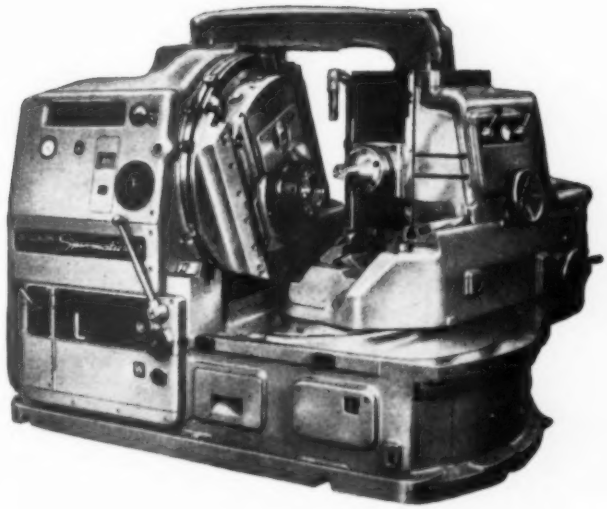
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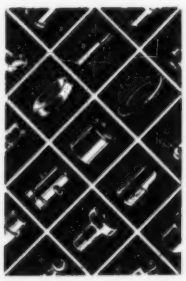
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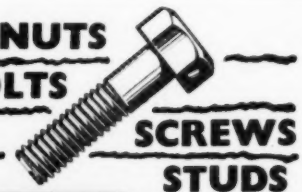
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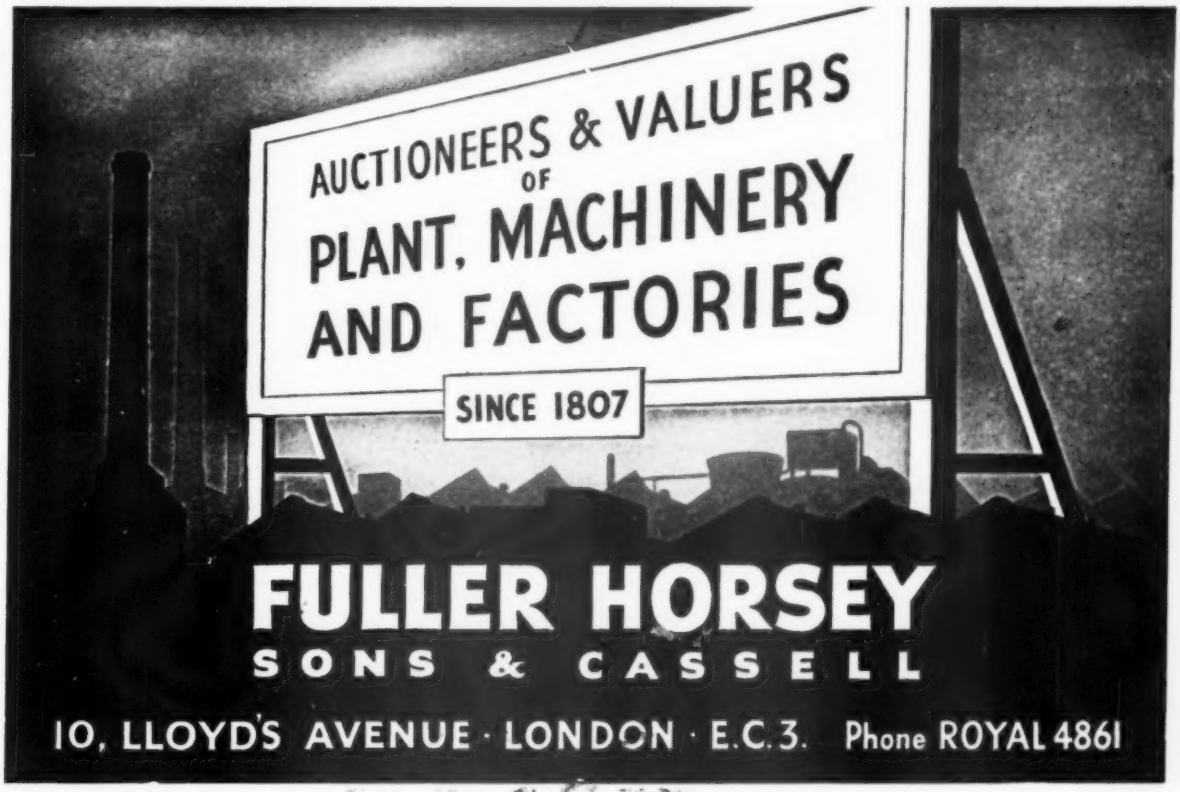
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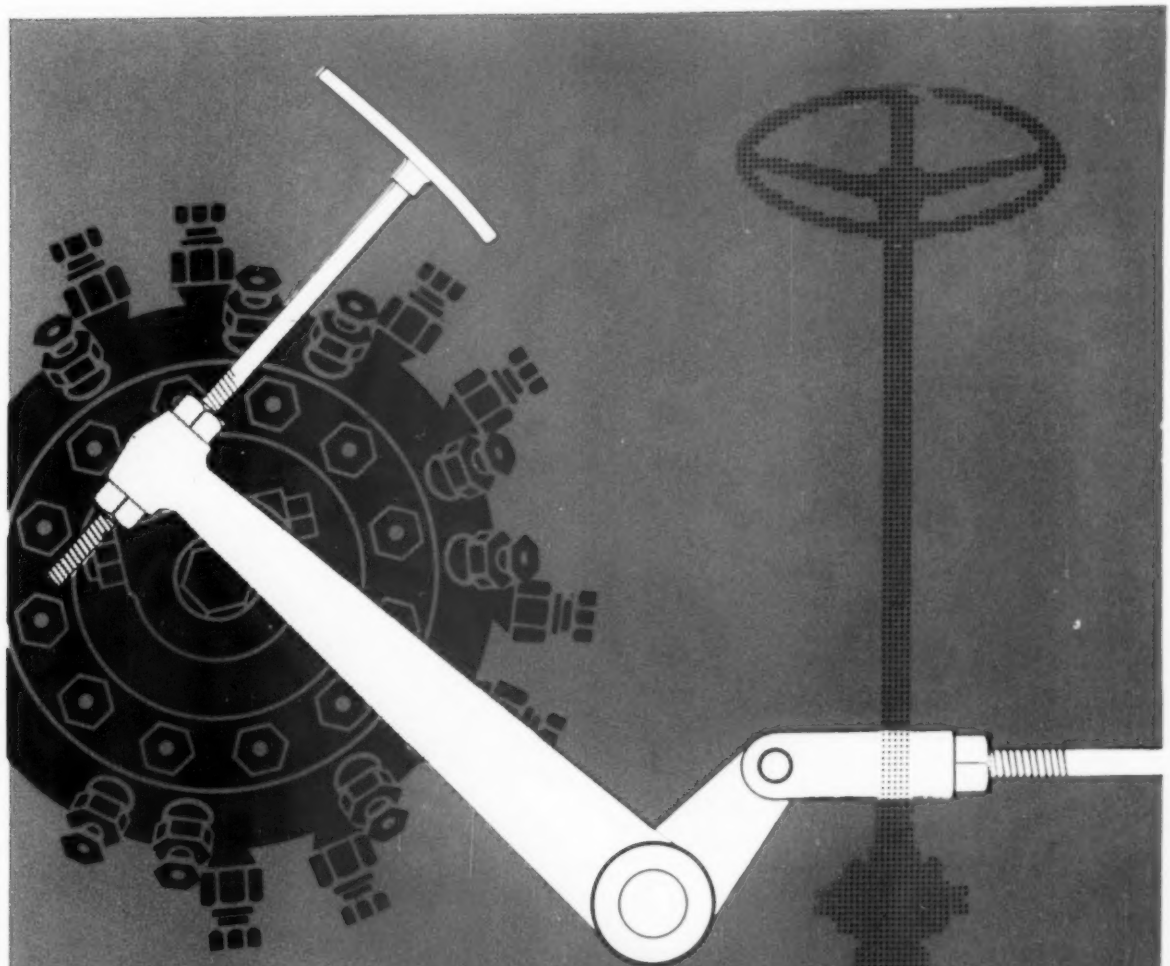
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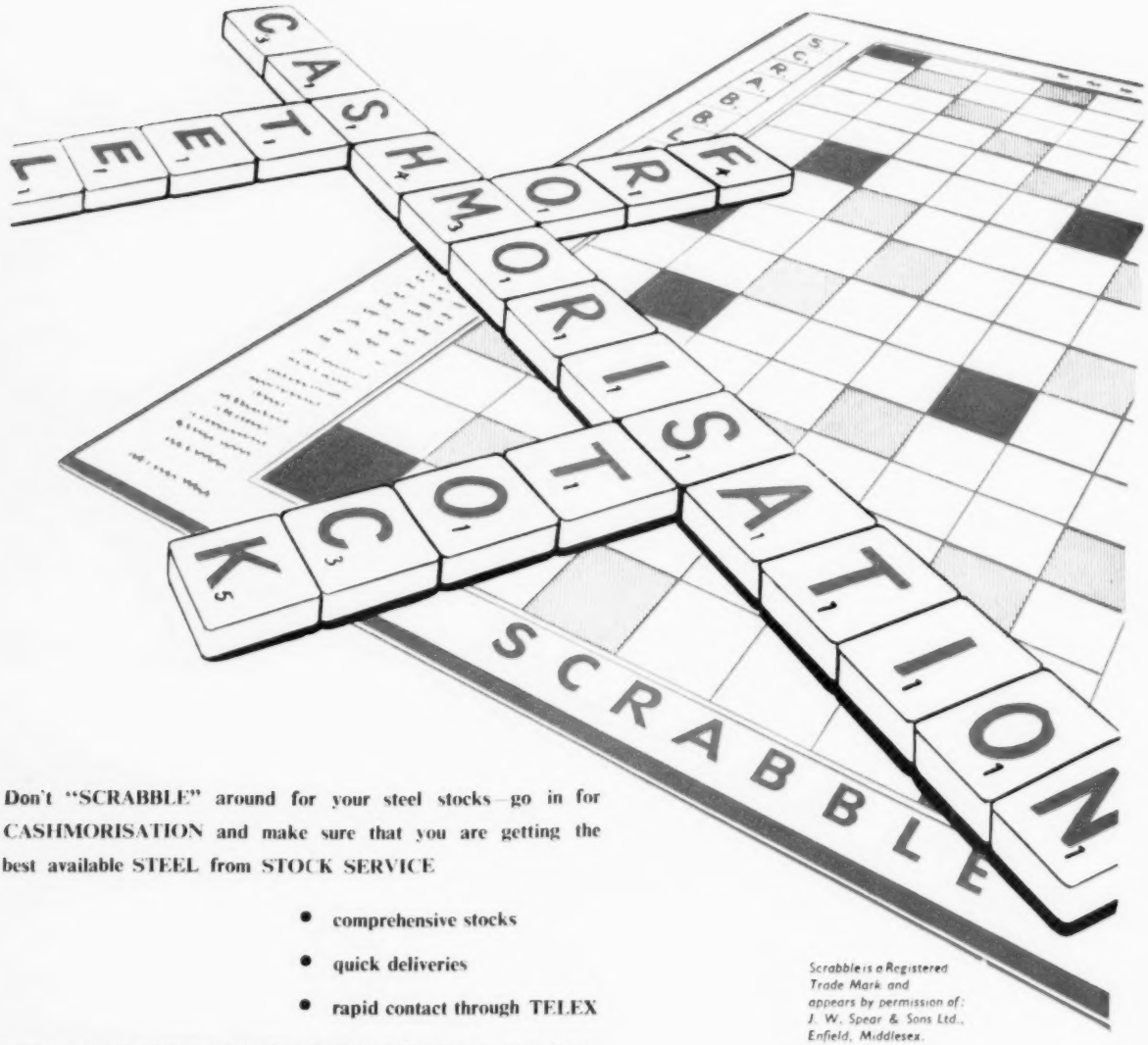
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